THE

REPERTORY

OF

ARTS AND MANUFACTURES:

CONSISTING OF

ORIGINAL COMMUNICATIONS,

SPECIFICATIONS OF PATENT INVENTIONS,

AND

SELECTIONS OF USEFUL PRACTICAL PAPERS

FROM THE

TRANSACTIONS

OF THE

PHILOSOPHICAL SOCIETIES

OF ALL NATIONS, &c. &c.

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CONTENTS

OF THE

TENTH VOLUME.

Page

I. Specification of Mr. CARTWRIGHT's Patent for Improvements in Steam-Engines, — 1

II. Specification of Mr. VARLEY's Patent for a new Perpetual Moving Power, — — 9

III. Specification of Mr. HODSON's Patent for separating foſſil Alkali from common Salt, &c. 12

IV. Specification of Dr. SHANNON's Patent for improving the Proceſſes of brewing, diſtilling, boiling, &c. — — — 17

V. Deſcription of a Method of rendering the Telegraph capable of conveying Intelligence in the Night, — — — 28

VI. On different blue Colours, produced from the Mother-Water of Soda Phoſphorata, &c. By Mr. THOMAS WILLIS, — — 32

VII. Farther Remarks on the Cauſe of the Smut in Wheat. By Mr. JOSEPH WIMPEY, — 41

VIII. Obfervations on the fundamental Property of the Lever. By the Rev. SAMUEL VINCE, A. M. 49
IX. On painting in Oil, in the Manner of the Venetian School. By Mr. TIMOTHY SHELDRAKE, — — — 56
X. On the Effect of Mordants in dying Cotton red. By I. A. CHAPTAL, — — — 63
XI. Lift of Patents, — — — 71
XII. Specification of Mr. AUGHTIE's Patent for an Improvement in Coffins, — — 73
XIII. Specification of Mr. WELDON's Patent for a Mill for grinding Bark, &c. — — 77
XIV. Specification of Mr. ROW's Patent for Mineral Lamp-Black, — — 81
XV. Specification of Mr. BLUNDELL's Patent for a Machine for faving Fuel, called the Economical Receiver, — — — 84
XVI. Experiments upon the Refiftance of the Air. By RICHARD LOVELL EDGEWORTH, Efq. 87
XVII. Obfervations on Iron and Steel. By Mr. JOSEPH COLLIER, — — — 97
XVIII. Conclufion of Mr. SHELDRAKE's Differtation on painting in Oil, in the Manner of the Venetian School, — — — 113
XIX. Method of preferving young Trees from being injured by Hares, &c. By WILLIAM PATTENSON, Efq. — — 123
XX. On the Ufe of Oxides or Calces of Iron in dying Cotton. By J. A. CHAPTAL, — 125
XXI. On making Paper afrefh, from Leaves of Books, Letters, &c. By Meffrs. DEYEUX, MOLARD, PELLETIER, and VERKAVEN, — 136
XXII. Lift of Patents, — — — 143

XXIII.

Page

XXIII. Specification of Mr. RICHARDSON's Patent for a Machine to be applied to Spectacles, — 145

XXIV. Specification of Mr. HOWARD's Patent for a Machine for cooking Victuals, called the Pneumatic Kitchen, — — — 147

XXV. Specification of Mr. DUNNAGE's Patent for ventilating the Crowns of Hats, — 149

XXVI. Specification of Mr. RALEY's Patent for a Philosophical Furnace and Boiler, &c. — 155

XXVII. On the Procefs of bleaching with oxygenated muriatic Acid. By THEOPHILUS LEWIS RUPP, — — — 165

XXVIII. Account of the Means employed to obtain an overflowing Well. By Mr. BENJAMIN VULLIAMY, — — — 181

XXIX. On the chemical Properties attributed to Light. By BENJAMIN Count of RUMFORD, — 189

XXX. Conclufion of Meffrs. DEYEUX, MOLARD, PELLETIER, and VERKAVEN's Inftructions for making Paper afrefh from Leaves of Books, Letters, &c. — — — 200

XXXI. On the Ufe of fine Wire-work or metallic Gauze, as a Subftitute for Horn, in making Lanterns for the Navy. By ALEXIS ROCHON, 207

XXXII. Lift of Patents, — — — 215

XXXIII. Specification of Mr. MEIKLE's Patent for a Mill or Machine for feparating Corn from the Straw, — — — 217

XXXIV. Specification of Mr. BENTHAM's Patent for new Methods of working Wood, Metal, and other Materials, — — 221

XXXV. Specification of Mr. DANFORTH's Patent for condenfing the Vapour arifing in Diftillation, 250

XXXVI. Defcription of an improved Method of laying Water-Pipes. By Mr. J. C. HORNBLOWER, 25[illegible]
XXXVII. Conclufion of Count RUMFORD's Inquiry concerning the chemical Properties attributed to Light, — — — 257
XXXVIII. Defcription of a portable Machine for loading and unloading Goods. By Mr. GEORGE DAVIS, — — — 273
XXXIX. On the Means of improving the Art of Hat-making. By M. CHAUSSIER, — 275
XL. Account of a Method of encreafing the Force of Gunpowder. By DOMINICK VANDELLI, 286
XLI. Lift of Patents, — — — 287
XLII. Specification of Mr. PONTIFEX's Patent for an improved Still-Head, for diftilling all Sorts of Liquor, — — — 289
XLIII. Continuation of Mr. BENTHAM's Patent for new Methods of working Wood, Metal, and other Materials, — — — 293
XLIV. Specification of Mr. WOODS's Patent for a Hand-Pump, for raifing Water out of Ships, &c. 321
XLV. Specification of Mr. RICHTER's Patent for inlaying Scagliola or Plafter upon Marble and Metals, — — — 326
XLVI. Defcription of an Inftrument called a Sward-Cutter, and of two Harrows. By the Honourable ROBERT SANDILANDS, — 329
XLVII. On the Rectification of Sulphuric Ether. By M. DIZE', — — — 343
XLVIII. Manner of polifhing and filvering Plates for Looking-Glaffes (caft at St. Gobin) at the Fauxbourg St. Antoine, at Paris. By M. SAMUEL BERNARD, — — 351
XLIX. Lift of Patents, — — 359

L.

Page
L. Specification of Mr. Curr's Patent for making a flat Rope, for drawing Coals, &c. out of Pits, 361
LI. Conclusion of Mr. Bentham's Patent for new Methods of working Wood, Metal, and other Materials, — — — 367
LII. Specification of Mr. Collier's Patent for purifying Fish-Oils, for improved Strainers for Oils, and for Instruments for ascertaining their Qualities, and assisting their burning, — 389
LIII. Specification of Mr. Crawford's Patent for a new Method of tinning Copper, — 397
LIV. Description of a new-invented Fire-Ship. By Mr. Edward Thomason, — — 399
LV. Conclusion of M. Bernard's Account of the Manner of polishing and silvering Plates for Looking-Glasses, — — — 405
LVI. On the Means of separating Zinc combined with Copper; with the Analysis of some Greek and Roman Coins. By M. Dizé, — 416
LVII. List of Patents, — — 431

PLATES

PLATES

IN THE

TENTH VOLUME.

		Page
1 and 2.	Improvements in Steam-Engines, —	8
3.	Perpetual Moving Power, and Furnace for ſeparating foſſil Alkali from common Salt, &c.	11. 16
4.	Method of rendering the Telegraph capable of conveying Intelligence in the Night, —	30
5.	Improvement in Coffins, — —	76
6.	Mill for grinding Bark, &c. — —	80
7.	Machine for ſaving Fuel, — —	86
8.	Furnace for making Steel, — —	112
9.	New-conſtructed Spectacles, and Pneumatic Kitchen,	148
10.	Method of ventilating the Crowns of Hats, —	154
11.	Apparatus for Bleaching, — —	180
12.	Overflowing Well, — —	188
13.	Mill for ſeparating Corn from the Straw, —	220
14.	Improved Method of laying Water-Pipes, —	256
15.	Portable Machine for loading and unloading Goods,	274
16.	Improved Still-Head, — —	292
17.	Hand-Pump for raiſing Water out of Ships, &c.	324
18.	Sward-Cutter, and two Harrows, —	342
19.	Machine for making a flat Rope, —	366
20.	Apparatus for purifying Fiſh-Oils, &c. —	396
21.	New-invented Fire-Ship, — —	404

REPERTORY
OF
ARTS AND MANUFACTURES.

NUMBER LV.

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I. *Specification of the Patent granted to* EDMUND CARTWRIGHT, *of the Pariſh of St. Mary-le-Bone, in the County of Middleſex, M. A.; for Improvements in the Conſtruction, Working, and Application of Steam-Engines.*

WITH TWO PLATES.

Dated November 11, 1797.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE, that, in compliance with the ſaid proviſo, I the ſaid Edmund Cartwright do hereby declare, that my improvements in the conſtruction, working, and application of ſteam-engines, are as follows.

Firſt. I conſtruct the engine ſo as that the water, or whatever other fluid I make uſe of, ſhall, in

the course of its operation, whether in the ſtate of ſteam or otherwiſe, circulate through it; and this without any communication with the external air, and without any commixture of cold water, or other extraneous fluid.

Secondly. I make the working-cylinder and the piſton to act upon principles ſimilar to thoſe of the common ſucking-pump; the cylinder being ſupplied in the ſame manner, with ſteam, as the barrel of the pump with water; ſave that in the one caſe the valves are ſelf-acting, in the other they have action given them. In conſtructing an engine upon this principle, the piſton muſt be provided with a valve, in like manner as the ſucker of a pump with a clack. The piſton-valve being cloſed, (which it is made to do by means of a ſpindle, which goes through it, ſtriking againſt a ſpring or weight at the top of the cylinder,) and the vacuum being produced, the piſton makes its ſtroke, and, at the ſame time, (the ſteam-valve being then opened, by the top of the piſton ſtriking againſt a ſpindle which goes through the valve,) draws ſteam into the cylinder, exactly as the ſucker draws up water into the barrel of the pump. The ſtroke being made, the piſton-valve opens, (by the ſpindle which goes through it ſtriking againſt the bottom of the cylinder,) and the piſton is thereby enabled to return freely through the ſteam in the cylinder,

(the

(the ſteam-valve being cloſed, by a ſpring or weight brought down by the piſton-rod ſtriking againſt it,) in the ſame manner as the ſucker of a pump returns through the water in the barrel. The piſton-valve then cloſes, and the ſteam-valve opens, and the ſtroke is repeated as before.

Note. The ſteam and piſton valves are kept open, when required, by ſprings preſſing againſt the ſpindles which run through each of them reſpectively; by means of this conſtruction, the condenſation (as will appear by what follows) is always taking place during the whole time of working, whether the piſton is deſcending or aſcending: were this not the caſe, the condenſation, (which, as I manage it, is regularly progreſſive, and not inſtantaneous,) would be too ſlow.

Thirdly. To produce a vacuum, I condenſe, upon the common principles of diſtillation, by the external application of cold to the veſſel or apparatus through which the ſteam paſſes. This apparatus may be variouſly formed. That which I moſt approve is compoſed of two metal cylinders, one within the other, laid ſo near together as that the cold of their reſpective ſurfaces may act as immediately as poſſible upon the ſteam which is admitted between them. The cylinders are kept cold by ſtanding in a refrigeratory of cold water, ſo contrived as that the

water ſhall come in contact with the outſide of the exterior cylinder, and the inſide of the interior one. I purpoſe, in ſome caſes, to aſſiſt the condenſation by having the condenſer wrapped in woollen or other cloths, kept conſtantly wetted, and to have a ſtrong current of air blowing upon them, to make the condenſing-water evaporate. This, or whatever other condenſing apparatus is made uſe of, has a conſtant and open communication, at all times, with the ſteam-cylinder. The condenſed fluid, falling to the bottom of the condenſing-apparatus, is propelled by a pump, through a pipe, back again into the boiler. The pipe through which it is propelled paſſes through a box, in the top of which is a buoyant-valve, ſo conſtructed, by means of a ball-cock or otherwiſe, as to ſuffer the air, when it riſes to a certain height in the box, to eſcape: the fluid, as it riſes, buoys up the ball-cock, and ſhuts the valve, and then, flowing on, repaſſes into the boiler. By means of this valve, the engine, after a certain period, becomes nearly, if not totally, purged of all its air, or elaſtic vapour; in conſequence of which, a vacuum, little if any ſhort of an abſolute one, is obtained; which, upon any other principle hitherto practiſed, is known to be impoſſible.

Fourthly. I make the piſton entirely of metal, without any packing whatever, which is thus done.

done. The base of the piſton being ſomewhat leſs than the bore of the cylinder, and its ſurface being made as true and ſmooth as may be, a flat metal ring, equally true and ſmooth, is laid upon it, divided, into ſegments, (whoſe ends are alſo accurately fitted to each other,) which ring completely fits the cylinder; within the ring lies a ſpring preſſing it outwards, but ſo contrived, by taking its bearings from two adjoining ſegments, as that the ring, ſhould it expand, will only open between the ſegments from which the ſpring takes its bearings. This opening is ſecured by a ſegment of a ring lying upon it, and another behind it; which two ſegments are alſo kept to their places by ſprings preſſing them outwards. The whole is kept from riſing off the baſe by another flat ring, accurately fitted and held down by an adequate preſſure, but not ſo great as to impede the ſegments from gliding freely upon the baſe.

The piſton-rod is alſo packed upon the ſame principle, that is to ſay, ſolely with metal, which is thus done. The top of the cylinder being made true and ſmooth, a flat ring, cut into ſegments, lies upon it, and embraces the piſton-rod, towards which it is preſſed inwards by ſprings; this ring is incloſed by another, divided into ſegments, and to which it is preſſed inwards by ſprings: the ſegments of the inner and the outer ring

ring muſt be ſo placed as to break joint. The two rings are covered by a third, which is held down by any adequate preſſure, as in the piſton: the whole may be encircled in a box for holding oil, &c.

Fifthly. I conſtruct the rotary engine of Mr. Watt, the patent for which is dated March 12, 1782, and is now expired, ſo as that it ſhall act with double power, and without the neceſſity of a heavy fly-wheel, as directed in his ſpecification, (to which ſpecification I refer for the more perfect underſtanding of his invention,) which is thus done. The axis has any unequal number, not leſs than three, which number I account the beſt, of what Mr. Watt calls piſtons upon it, ſo diſpoſed that no two ſhall be oppoſite. In the cylinder, in which the axis revolves, are two valves, at oppoſite ſides of the cylinder. On one ſide of each valve is a pipe, for the admiſſion of ſteam; on the other, a pipe communicating with the condenſer. Or I make the number of piſtons equal and oppoſite, and the number of valves, ſteam-pipes, and condenſing-pipes, unequal and not oppoſite. Or I make the valves attached to the axis, and, in place of the valve, I make fixed diviſions in the cylinder, in the manner preſcribed by Mr. Watt. It is obvious that, the number of piſtons and valves not correſponding, ſome one or other of them will always be in action on one ſide

ſide or the other of the cylinder. The engine conſequently will have no tendency to ſtop, and therefore a fly-wheel will not be abſolutely neceſſary, eſpecially a heavy one.

Sixthly. I work the engine not only with water, but alſo with ardent ſpirit, or æther, or any other ſpirit more volatile than water, either wholly or in part; or with diſtillers waſh, or with any other fermented fluid yielding ardent ſpirit by diſtillation.

Seventhly. I purpoſe to apply the engine not only as a mechanical power, but alſo as a ſtill, at one and the ſame time. In this caſe, the condenſed fluid, inſtead of being returned into the boiler, will fall into a proper receiver; perhaps it will be beſt, after it quits the engine, to go into a worm-pipe, that it may have time to get ſufficiently cold before it falls into the receiver.

Laſtly. All theſe ſeveral improvements I mean to apply either collectively or ſeparately, wholly or in part, to all engines that are in public uſe, and to all other engines at the expiration of their reſpective patents.

The annexed plates, to which the following figures and letters refer, will farther explain the above ſpecification. (See Plates I. and II.)

Fig. 1. (Plate I.) A. The cylinder. B. The ſteam-valve. C. A ſpring, fixed to the piſton-rod, for ſhutting the ſteam-valve. D. Pipe communicating

nicating with the condenſer. E. The condenſer. F F. The internal cylinder of the condenſer. G G. The external cylinder of the condenſer. H. Pipe leading from the condenſer to the pump. I. The pump. K. Pipe leading from the pump to L, the air box. M. Pipe leading back into the boiler.

Fig. 2. (Plate II.) Plan of the piſton. A, B, C, D, E, F. Segments of the flat ring lying upon the baſe. G. Segment covering the opening, both at the top and behind, between the ſegment A and F. H. The ſpring preſſing the ſegments outwards. I. A ſpring lying at the back of G.

Fig. 3. Shews the piſton with the ſegments covered.

Figs. 4 and 5. Sections of the piſton, ſhewing the valve.

Fig. 6. The air-box. A. The valve. B. The ball buoying up the valve after the air has eſcaped.

Fig. 7. The improved rotary-engine. A. The cylinder. B. The rotary part of the engine, with its three piſtons. C, C, Two oppoſite valves, turning upon their axes, D, D. E, E. Two oppoſite ſteam-pipes. F, F. Two oppoſite pipes, each leading to the condenſer. In witneſs whereof, &c.

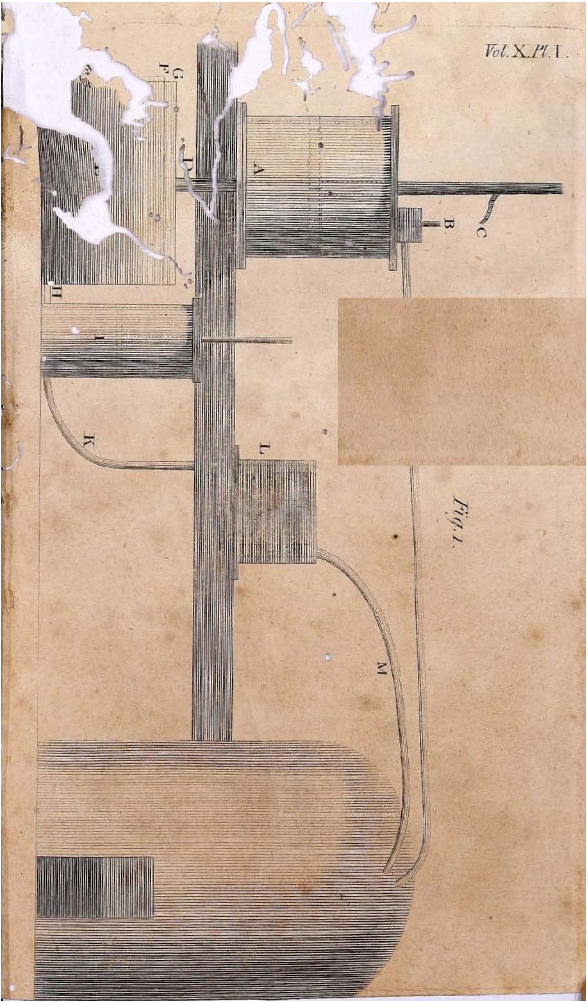
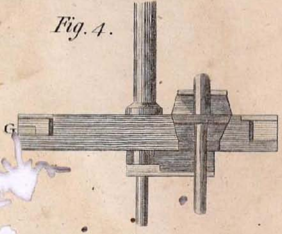


Fig. 1.



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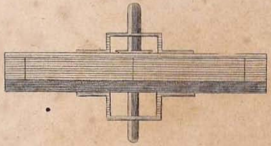

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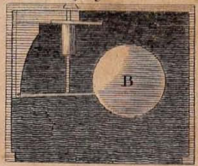

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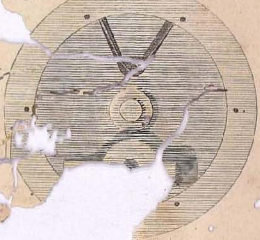


Fig. 3.

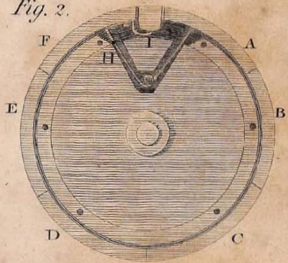


Fig. 2.

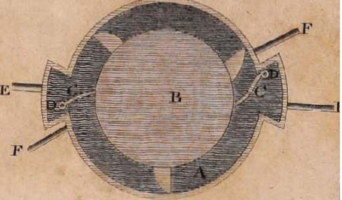


Fig. 7.

II. *Specification of the Patent granted to Mr.* Richard Varley, *of Dimside, near Bolton-le-Moors, in the County of Lancaster; for his Invention of a new Perpetual Moving Power.*

WITH A PLATE.

Dated May 29, 1797.

To all to whom theſe preſents ſhall come, &c. Now know ye, that I the ſaid Richard Varley, in compliance with the ſaid proviſo, do hereby deſcribe and aſcertain the nature of my ſaid invention, and declare that the ſame is compoſed of the ſeveral particulars in the plan thereof hereunto annexed, and the following deſcription thereof; that is to ſay: My invention conſiſts of a method of applying the weight of the atmoſphere upon a wheel in any other fluid, and by that means deſtroying its ſpring or reaction; the manner of doing which I deſcribe as follows, agreeable to the figure annexed. A, (Plate III. Fig. 1.) is a circular veſſel, made of copper, or any other ſubſtance capable of containing water,

and covered with a top part, ſo as to be perfectly air-tight. B, is a wheel, placed in the inſide of the veſſel, with its axle perpendicular, the uppermoſt part of which comes through the top of the veſſel, and is made to work air-tight; the lower end runs in a ſtep within the veſſel, and no part of the wheel is to touch the veſſel but its axis. C, is a cylinder, placed firmly upon the wheel. D, is the piſton, ſuſpended by a chain to a ſtrong ſpring fixed on the wheel; this ſpring is to be made of ſuch ſtrength, that when the whole weight of the atmoſphere is upon the piſton, the air will only move it about one inch down. E, is the tube leading from the axle, which is hollow from the top to the level of the wheel, ſo as to admit the external air, by this tube, to the piſton D; which piſton is a circular veſſel, made air-tight, and exactly fits the cylinder. There is a joint in the tube E, at F, which is made air-tight by leathers, ſo that, when the piſton deſcends, the tube may give way to it. G, is a ſmall tube, leading from the bottom of the cylinder to the centre of the axle, and thence brought out of the end of it, and by which the air is extracted from the cylinder, and a vacuum formed in it, by means of an air-pump. On the top part, or any other convenient place of the veſſel, are fixed two cylinders or tubes, of a proportionate ſize to the cylinders on the wheel;

one

one of which is a condenſing cylinder, by means of a ſcrew and piſton, and by which the water in the veſſel may be compreſſed; the other has its piſton ſuſpended at the bottom; and the top part of the cylinder being filled with air, as the other piſton is ſcrewed down, this riſes and condenſes the air in the cylinder, the ſpring of which keeps the water in the veſſel preſſed to all parts alike; and, when the air is extracted from the cylinder C, and the piſton D is forced down by the external atmoſphere into the cylinder, this preſſure is continued, and the condenſed air expands in proportion, and prevents any tendency to a vacuum being formed, which would cauſe a coheſion of all the parts. By this means, the external air is ſuſpended upon the wheel by the chain, the ſame as a weight; and the ſpring of the atmoſphere being taken from the cylinder, there is nothing to oppoſe this weight, there being no ſpring in water. And this power may be increaſed, in proportion to the ſize and number of cylinders on the wheel, and its diameter. In witneſs whereof, &c.

III. *Specification of the Patent granted to Mr.* GEORGE HODSON, *of the City of Chester; for an improved Method of separating the fossil or mineral Alkali from the muriatic Acid, as it exists in common Salt; and also of separating the fossil or mineral Alkali from the common Salt, as it exists in Kelp; also of separating the fossil or mineral Alkali from the muriatic Acid, as it exists in Salt-Rock, common Salt, Brine, Sea Water, in the common or neutral Salt of Natron, Soda, Sal Enixum, Caput Mortuum of Spirit of Salt, Kelp, and Salts obtained from Soapers Leys**.

WITH A PLATE.

Dated Feb. 28, 1797.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said George Hodson do hereby declare, that the nature of my said invention, and the manner in which the same is

* Mr. Hodson's former patent for the same purpose is given in our second volume, page 14.

to

to be performed, is particularly described and ascertained as follows; that is to say: To obtain the fossil or mineral alkali from salt-rock, common salt, brine, and sea-water, I proceed as follows: having prepared three hundred weight of well burnt quick-lime, I slake the same with a strong brine, continuing to sprinkle it therewith until the salt appears to be accumulating on its surface. The lime, thus slaked and saturated with salt, must be spread into thin layers, until the evaporation is completed, and then thrown into the reverberating-furnace, (see Plate III. Fig. 2.) at the door E; to which afterwards must be added three hundred weight of salt or salt-rock, in a shelly state, and the whole, with a strong heat, brought into a flux. When this is effected, two hundred weight of gypsum, and two hundred weight of sal enixum are to be introduced, and, by means of repeated stirring with the rake, (see A, in the said figure,) the different materials must be as generally and as uniformly distributed as possible. Two spades full of small-coal, coaks, or charcoal, must then be thrown into the furnace, and, by means of stirring as before, intimately united with the whole mass; and this must be repeated, at intervals of the space of one quarter of an hour, until two hundred weight of charcoal be consumed; if coaks are used, until three hundred weight; if small-coal, until four hundred

hundred weight be consumed. The process must then be continued, without any farther admixture, with a strong heat, for three or four hours, or more, according to the degree of purity which it is designed the ash should possess. After which, the fluid mass is to be extracted, by means of the rake, at the door, (see E, in the figure,) and, when cold, broke up into lumps for use. I vary the process just described, as follows: I cast into the furnace three hundred weight of gypsum, previously broken into lumps of about two pounds weight each, and expose it, for the space of two hours, to the action of a violent heat. I afterwards add three hundred weight of salt or salt-rock, in a shelly state, which having closely united itself with the gypsum, I proceed to introduce one hundred weight of charcoal, or coaks, or small-coal, in the proportions stated in the first process, stirring the whole mass frequently with the rake. When the combustion of the coal is nearly extinct, I throw into the furnace one hundred weight of vegetable alkali, or two hundred weight of sal enixum, or two hundred weight of black-ashes, principally for the purpose of attenuating the mass. The union of all the materials being accomplished, I add about two hundred weight of charcoal, two spades full at a time, at intervals of the space of one quarter of an hour each. The process is then to be continued

nued for three hours, or more, &c. &c. as defcribed in the former procefs.

In order to obtain the foffil or mineral alkali from the natural falt of kelp, from foda, and from caput mortuum, of fpirit of falt, having previoufly reduced either of thefe articles into lumps of about two pounds weight each, I throw into the furnace about ten hundred weight thereof, with four hundred weight of gypfum, or four hundred weight of foapers wafte. I afterwards introduce two hundred weight of charcoal, at intervals of the fpace of one quarter of an hour each, and continue ftirring the mafs with the rake, until the decompofition is effected; which will happen in about ten hours, computing from the commencement of the procefs.

To obtain the foffil or mineral alkali from the neutral falts of natron and fal enixum, I throw into the furnace five hundred weight of natron, or of fal enixum, with four hundred weight of gypfum, or four hundred weight of foapers wafte. To thefe I add two hundred weight of black afhes, or of falts obtained by evaporation from foapers leys four hundred weight; all which materials being brought into ftrict combination, I add two hundred weight of charcoal, at intervals of the fpace of one quarter of an hour each, and continue the procefs for about ten hours, computing, as before, from the commencement of it.

In

In obtaining the fossil or mineral alkali from black ashes, or other salts obtained from soapers leys, I put into the furnace five hundred weight of black ashes, or uncalcined salts nine hundred weight, together with four hundred weight of gypsum, or of soapers waste. When these materials are completely fluxed, I add two spades full of charcoal, at intervals of the space of one quarter of an hour each, until two hundred weight thereof is introduced; the materials are to be well united by means of the rake, and to remain in the furnace for about eight hours, computing from the commencement of the process; at the expiration of which, the mass must be drawn out at the door E, (see the figure,) and, after induration, broken up into lumps for use, as in the first and all the subsequent processes. In witness whereof, &c.

References to the Figure.

(See Plate III. Fig. 2.)

A. The rake (13 feet long) by which the substances are stirred.

B. The bottom of the furnace.

C. The chimney.

D. The door of the furnace.

E. Entrance by which the materials are put in and taken out.

F. Flue.

Fig. 1.

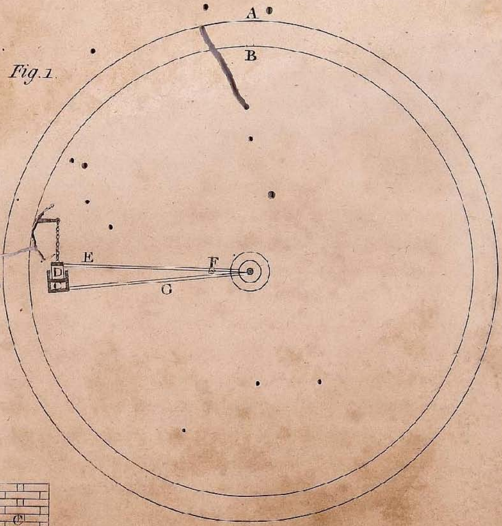
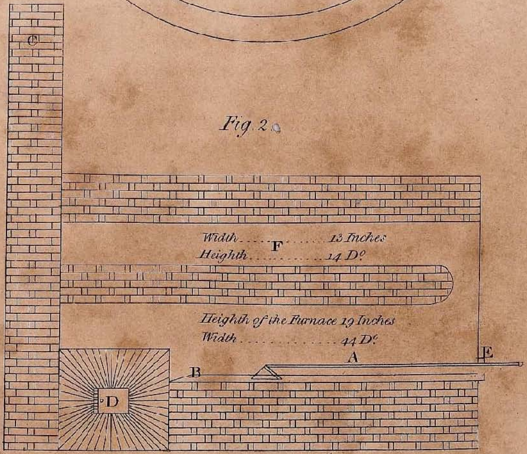

A
B
D
C
E
F
G

Fig. 2.


C
Width .... F .... 13 Inches
Heighth .... 14 D°.
Heighth of the Furnace 19 Inches
Width .... 44 D°.
A
E
B
D
10 feet.

IV. *Specification of the Patent granted to* RICHARD SHANNON, *of the Parifh of St. Pancras, M.D.; for his Method of improving the Proceffes of brewing, diftilling, boiling, evaporating, raifing, applying, and condenfing, Steam or Vapour, from aqueous, fpirituous, faccharine, faline, and other Fluids.*

Dated Feb. 1, 1798.

TO all to whom thefe prefents fhall come, &c. NOW KNOW YE, that in compliance with the faid provifo, I the faid Richard Shannon do hereby declare, that my faid difcovery and application of a new principle for improving the proceffes of brewing, diftilling, evaporating, raifing, applying, and condenfing, fteam or vapour, from aqueous, fpirituous, faccharine, faline, and other fluids, which expedites the procefs, improves the quality, and caufes a great faving of time, fuel, and expence in each, with the invention of a fuitable apparatus and utenfils, on an improved principle, correfpondent to thefe intentions, (part of which improvements are applicable to the utenfils now in ufe,) are defcribed in

 the

the manner following; that is to ſay: By covering and making the maſh-tun air-tight, and caſing it round, under and over, with a ſteam-tight caſing, ſo as, during the maſhing and ſoaking of the malt and grain uſed, the heat may be preſerved, or raiſed and regulated to any pitch, by the application of ſteam, both in and between the caſing of the maſh-tun; by which contrivance, the whole of the *farina* and ſubſtance of the grain may be as effectually extracted in one, or at moſt in two maſhings, as is now done in three or four. The ſteam, conducted by a proper tube or pipe, is to be alſo employed for ſweetening and cleanſing all the brewing, diſtilling, and vinegar-making utenſils, and caſks employed in each, &c. ſo as in future to prevent furring, foxing, &c. even in the inmoſt crevices.

The coolers for cooling the worts are to have double bottoms; the firſt, in which the worts are laid, ſhould be a grated, railed, or latticed bottom, covered with lead, (wood having infinitely leſs conducting power than metals,) for quickly conducting or tranſmitting the heat of the worts and waſh to the atmoſphere, or any other cooling medium employed; the outer or under bottom may be made of wood, as uſual: between theſe, cold air or water is to be impelled, to expeditiouſly cool the worts, by imbibing and carrying off the heat. The heated water to be employed

for

for the purpoſes of brewing, &c. and the heated air for the combuſtion of the fuel under the brewing-coppers, ſtills, &c.; by which contrivance, air may be paſſed with a velocity that compenſates for its being 850 times lighter than water. By theſe means, the worts can be laid to any thickneſs, and cooled to any time. This is much facilitated by a metallic pump, and flatted ſpiral tube, through which cold air or water is paſſed, during the aſcent and deſcent of the worts.

The brewing-coppers, ſtills, &c. are to be long cylinders, double at the ends, and to have proper arms, doors, and tubes, with the uſual means of charging and diſcharging them at preſent uſed, and of working them off, cleanſing, &c. They are to be of one, two, three, or more diameters long, that is, ſo many times longer than broad; by which means, the heat is brought nearer the centre of the contained fluid; under which, inſtead of one immenſe fire, (as now practiſed,) two or more are to be placed, in all of which together, not a quarter part of the fuel now uſed is applied. Theſe cylinders lying lengthways over the fires employed to work them, the flame and ſmoke will be made to paſs round them in a ſpiral direction, under and over, ſo as to apply every particle of heat to them and their contents to be heated, that nothing but ſuch part of the ſmoke as remains unburnt can reach the chim-

ney, (placed near the centre of the cylindric veſſel,) the flame and heat being depoſited in their circuit, by the number of convolutions round and round the cylinder, (in their paſſage to the chimney,) acting on it and its contents, from every inch of the circumference to the centre, along its axis.

Over each of theſe brewing-coppers, ſtills, &c. can be placed another copper, ſtill, &c. which, ſerving as a covering in of the flues of the under one, receives a full heat from them at its bottom; after which, the remaining heat, inſtead of paſſing into the chimney, makes a circuit round the ſides of the upper copper, ſtill, &c. and at length arrives at the chimney. The quick-boiling and copious ſteam of theſe coppers, ſtills, &c. ſurpaſſes every thing that can be poſſibly conceived, without deſtroying the veſſels, fire-work erections, &c. as the great fires at preſent do, and cauſes a very great ſaving of time, fuel, and expence, and the volatile parts of the hops and malt are ſaved by the condenſing-pipe attached. By the addition of one or two partitions, theſe long coppers may be divided into two or three ſhort brewing-coppers; and the flame of the fires, placed near each end of the copper, will cauſe the middle one to boil as ſoon as either of thoſe under which the fires are placed; by means of proper regiſters, the boiling in any of them is regulated. By this contrivance

trivance, these coppers may be alternately used, as occasion requires, either as one or three coppers; or the two worts can be boiled at each end, and the liquor or water in the middle; but innumerable are the advantages derivable from such a vessel. On the same principle, the steam boilers, evaporating pans, sugar pans, salt pans, pot and pearl ash boilers, soap pans, &c. &c. &c. and all other stills, coppers, boilers, pots, and pans, constructed in this manner, intended for raising, applying, and condensing steam or vapour, in brewing, distilling, or for any other purpose, and for evaporating aqueous, spirituous, saccharine, saline, and other fluids, whether double or single at the ends, that assume this shape, and to which the heat is applied in this or similar manner, to which the before-mentioned advantages attach, either in the whole or part, correspondent to these intentions, and the respective purpose for which each is designed.

As a wash-still, either attached to or detached from the spirit-still, that is, either with or without the one at top, it enjoys unparalleled advantages, in addition to those enumerated; *viz.* the being able to fill it quite up; there being no danger of its running foul; the commodiousness of its figure for a stiring-engine: the manner the flame and heat act on it, reverberated on all sides, uniformly penetrating from every inch of the circumference

cumference to the centre, along the whole axis of its cylindric length, without destroying it or the erections round it; it being all bottom, without a resting place for the gross parts to be deposited, from the beginning to the end of the boiling; they being here constantly driven to, and retained in, the coolest part of the still, that is, along its centre or axis, and having no place to be deposited on and burnt, as in other stills; which preserves the fluidity of the boiling-wash, and the purity of the distilled fluid; and purity is strength, as the spirit will appear heavier or weaker, by the hydrometer, in proportion to impurity.

As a spirit-still, many of these advantages attach, though used alone, without the addition of one at top of it; and, the larger scale these stills are made on, the more beneficial will it be to the rectifier, either for rectifying the raw spirits in, making gin, &c. while spirit of wine or cordials are distilling in the upper still, with the same fire and attendance. Indeed, there is no part of the process of distilling but to which they advantageously apply, whether the distilled fluid is aqueous, spirituous, or saline.

With respect to the West Indies, where fuel is always dear, and water often scarce, these stills and refrigeratories will be a treasure; as the condensation and refrigeration can be performed in them

them with but little fuel, and with or without water.

To receive and condenſe the prodigious cloud of ſteam or vapour that neceſſarily ariſes from theſe ſtills, (and which no worm could receive and condenſe,) I have invented a new refrigeratory or condenſer, to ſupply the place of the old worm; it is of leſs receptive capacity, and greater condenſing ſurface, broad and flat in each fold; by which, the heated ſteam or vapour is brought in immediate contact with the cooling ſurface; through each fold of which it uninterruptedly aſcends, agreeable to its own levity, and the phænomena of vapour and all vaporous exhalations, which are to riſe and float in the air; and not, as in the preſent practice of diſtilling, forced, after aſcending into the arm of the ſtill, to deſcend through each convolution or round of the worm, contrary to its ſpecific gravity, through a column of air heavier than itſelf.

In this refrigeratory, the preſſure of the atmoſphere is averted, by making the diſtilling fluid act as valves; by which means, and thoſe enumerated, from the ſame extent of ſurface, and in the ſame or leſs time, double, triple, or even quadruple the quantity of ſteam is raiſed, condenſed, and diſtilled off, with a heat below that now uſed, and the volatile parts, now diſſipated in the air, filtered through the condenſed fluid, and

and ſaved, to the great improvement of the quality and ſtrength of the diſtilled ſpirit, &c. The volatile parts of all fluids condenſed in this refrigeratory, are not only ſaved, but they come off infinitely cooler than uſual; and that ſtruggle proceeding from the action and re-action of the riſing vapour within the ſtill and aſcending air of the atmoſphere from without, which, by paſſing up the old worm, at the part they meet in, cauſes the point of ſtagnation where they counterbalance each other, (to overcome which reſiſtance, a heat above the boiling point is at preſent unavoidably applied,) is all completely obviated in this new refrigeratory; and the atmoſphere, which is the ſolvent and receptacle of all volatile bodies, prevented from abſorbing any thing here.

This rifrigeratory conſiſts of two broad and proportionably long metallic plates, formed into a zig-zag fold or folds, the interſtice between which is the flatted tube, in which the condenſation is peformed; the fold near the lower end, in which the arm of the ſtill enters to convey the ſteam or vapour, is the chamber of reception, under which is the diviſion forming the valve of ſeparation, both of which together form the condenſing-valve; where a few thinner folds than thoſe above (in which the condenſation is performed) commence, for completing the refrigeration

ration of the condenſed fluid, which drains or runs into a round tube, (in which there is a valve,) that conveys it out through the worm-tub, as in the common worm. The ſteam or vapour riſing or expanding through the number of folds above, numerous in proportion to the required effect, is terminated by a tube at top, to carry off the elaſtic air, and incondenſible parts, which deſcend without the upper folds, (as before mentioned,) and is inſerted in the firſt of the lower folds, and filtered through the condenſed fluid, before it makes its exit.

By the addition of a third correſpondent plate, a double refrigeratory is formed; and, by adding a fourth, they are commodiouſly ſeparated by a third interſtice, through which air or water may be paſſed for cooling them. This double refrigeratory may be uſed without a worm-tub: it may be made to ſerve two ſtills, by placing it in a worm-tub; or made to condenſe for one or two ſtills, without a drop of water, by paſſing the current of atmoſpheric air (inſtead of water) that ſupplies the combuſtion of the fire, for ſupporting it, under its correſpondent ſtill or ſtills; or, finally, it may be made to condenſe for both the waſh and ſpirit ſtill at once, in more ways than one.

Attemperater. This epithet, as here applied, is only another word for cooler. Either the ſingle, double,

double, or triple new refrigeratory, may be rendered eminently uſeful to malt diſtillers and brewers of every deſcription, for cooling the worts, with the utmoſt diſpatch, to the temperature of the atmoſphere, or to any required pitch for fermentation, in any given time, either by air or water; and, when employed in this way, ſhould be called attemperaters. Firſt, by filling the middle interſtice with the hot worts from the under-tun, or under-back, and obliging the air conſumed by the fires under the copper or ſtill to paſs through the two outer folds. Secondly, by filling the two outer interſtices with hot worts, and paſſing the air through the inner or middle fold: inſtead of air, water may be applied in a ſimilar manner. Laſtly, by placing the ſingle, double, or triple refrigeratory in a worm-tub, ſupplied in the uſual way with water, as practiſed by the diſtillers, (or in a round, ſquare, or oval vat,) and filling up the refrigeratory with hot worts, where they muſt quickly depoſit their heat, and are ſoon brought to the temperature of the atmoſphere, (or even lower,) by a continual ſupply of cold air, or water; the hot water ſerving to ſupply the copper for the next maſh. The refrigeratory or attemperaters are conveniently cleaned after the worts, by ſteam, and much more effectually than the coolers have hitherto been; no other form admitting of being ſo

quickly

quickly and commodiouſly cleaned; as may alſo cloſe maſh-tuns.

The major part, or the whole of theſe utenſils, are to be made of metal, ſtone, wood, glaſs, earthen-ware, and brick-work, and the uſual ſolder and cements, for plaſtering, lining, and uniting them, are to be employed.

Theſe improvements comprize uncommon expedition in boiling, maſhing, and cooling, evaporating, diſtilling, and condenſing, and a ſaving of time, fuel, and expence; excluſive of the convenience and advantage of turning night-work into day-work, preſerving cleanlineſs, and preventing foxing; and of making that uſeful agent, fire, ſubſervient to all theſe purpoſes, and at the ſame time the inſtrument of heat and cold, diveſting it of its deſtructive influence on the utenſils. In witneſs whereof, &c.

V. *Deſcription of a Method of rendering the Telegraph now made uſe of in this Country, capable of conveying Intelligence in the Night. In a Letter to the Editors.*

WITH A PLATE.

GENTLEMEN,

AT the preſent criſis, when ſwift intelligence is frequently of great import, the telegraph is found to be an inſtrument of infinite utility; but, at this ſeaſon of the year, when the days are ſo ſhort, the approach of darkneſs puts an end to that correſpondence, from which ſo much advantage may accrue.

An appendage then to the preſent telegraph, ſo as to render it fit to convey intelligence in the night, would certainly be a deſirable acquiſition. The preſent is ſubmitted to your inſpection, not under the ſuppoſition that in itſelf it might anſwer, but only with a view to give a kind of outline

line to ſome of your more enlightened correſpondents, upon which they might ſo improve, as to bring the object we now contemplate to the requiſite perfection.

The following are the means I think might be employed. Suppoſe ABCD, Fig. 1, (Plate IV.) to repreſent, when ſtanding alone, the exterior frame of one of the ſquares belonging to the preſent telegraph, in which moves the board that denotes the intelligence to be conveyed; it is obvious that, if projecting ſides are added, at AC and BD, and a top or roof at AB, a kind of box (without a bottom) will be formed; to which box, the piece ABCD, when upright, will form a back. Upon one ſide of this ſquare ABCD, which forms a part of the preſent telegraph, I would propoſe a metallic mirror to be fixed, which (to preſerve from the weather in the day-time, if thought neceſſary,) might be kept covered: when night came on, into this partition (of which ſix ſuch would be requiſite) ſhould be hoiſted an Argand-lamp, furniſhed with a plano-convex lens; which apparatus ſhould be put into a large glaſs veſſel, open only at the top, which would preſerve the lamp from being affected by any ſudden guſts of wind, as well as from the weather in general. To the ſide EF a ſquare board is to be fixed, by means of two hinges M, N, (Fig. 3.) ſo contrived

as

as to lift up and down by the cord which moves the board in the prefent telegraph: by this, the lamp would be rendered vifible or otherwife, as might be wanted; or, a better way would be, to let the board in the prefent telegraph be kept fixed in a horizontal pofition in the day-time, and, by lifting up the piece E F K L, (Fig. 3,) the lamp would be rendered vifible. When the telegraph is not at work, all the lamps fhould be vifible, and the changes might be determined at difcretion.

Fig. 1. reprefents the addition neceffary to be made to the prefent telegraph. The fides ABCD, BFDH, AECG, are all folid, together with the roof ABEF; but the fides EFGH and CDGH are open; the latter for the purpofe of affording a paffage for the lamp, when hoifted.

Fig. 2. reprefents the lamp inclofed. ABCD, the back of the board to which the mirror is fixed: *a*, is the lens for magnifying the light. In this figure, the fide BDFH is fuppofed to be taken away, in order to let the fituation of the lamp be feen.

Fig. 3. reprefents the whole apparatus.

It muft be obferved, that the roof ABEF, in the four undermoft boxes, muft be rendered capable of being elevated at the time the lamps are hoifted

Fig. 1.

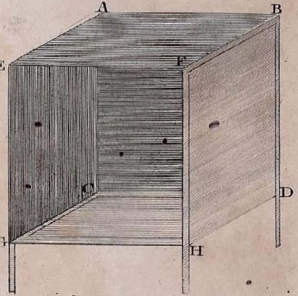


Fig. 2.

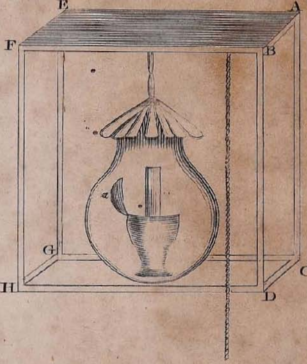
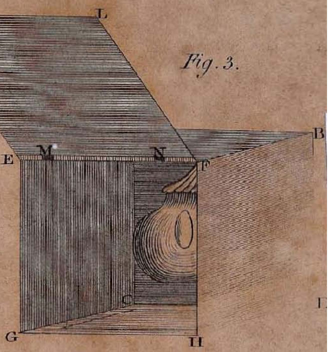


Fig. 3.



hoiſted into their reſpective ſituations, in order to afford a paſſage for them.

I am, &c.

October 8, 1798.

TELEGRAPHICUS.

A much more ſimple and (in our opinion) diſtinct kind of nocturnal telegraph is deſcribed in our firſt volume, page 382. But, as the preſent is an attempt to ſhew how the diurnal telegraph, now in uſe, may be converted into a nocturnal one, we have thought right to publiſh it. We fear, however, that Telegraphicus has not ſufficiently conſidered, that when the telegraph is uſed by day, both the open and ſhut ſpaces are ſeen, whereas, when uſed by night, the open (*i. e.* the illuminated) ſpaces only would be ſeen: hence, in many caſes, it would be difficult, if not impoſſible, to determine the real ſituation of the lamp or lamps; not to mention other difficulties, too obvious to require pointing out.

VI.

VI. *An Account of, and Obſervations on, different blue Colours, produced from the Mother-Water of Soda Phoſphorata, &c.* By Mr. THOMAS WILLIS, *of London.*

From the MEMOIRS of the LITERARY and PHILOSOPHICAL SOCIETY of MANCHESTER.

ACCIDENT led to the diſcovery of theſe colours, which it is to be hoped will be found uſeful in the art of painting. Two of them have ſomething of the appearance of Pruſſian blue; but, from the following inveſtigations, there ſeems to be ſome other principle beſides phlogiſticated alkali for their baſis; which I muſt confeſs I am not able to account for, but leave it to the judgement of gentlemen of greater abilities than I can pretend to.

After I had extracted all the cryſtals of ſoda phoſphorata from a combination of the phoſphoric acid with pure mineral alkali, or with the beſt Spaniſh barilla, freed from common ſalt as much as poſſible, I generally threw away the mother-water as uſeleſs, which being poured through

through an iron grating, ſome of it was ſcattered about, and appeared of a blueiſh colour on the contiguous ſtones; upon which appearance, imagining it to proceed from a phlogiſticated alkali, I diſſolved four ounces of common alum, and one ounce of martial vitriol, in two quarts of water, by boiling them together. On ſome of the mother-water of ſoda phoſphorata was poured a little of the aluminous and martial ſolution: at firſt a greyiſh coagulum only was formed; but, upon adding more of the ſolution, a fine blue colour was produced, which readily precipitated. This, being waſhed frequently with water, till the ſupernatant liquor was quite taſteleſs, was then dried, and produced the colour No. 1.

As I was deſirous of ſeeing whether rock-alum would have any different effect, four ounces of rock-alum, and one ounce of martial vitriol, were diſſolved in two quarts of water, by boiling them together; with ſome of this ſolution a precipitate from the mother-water of ſoda phoſphorata was produced, which, after it was well waſhed, yielded the blue colour No. 2, which is of a very pale hue.

A ſmall quantity of theſe powders was given to a perſon that paints in water-colours, who, on trying them, ſaid they were too ſpungy for that purpoſe.

As there was a very copious light precipitate produced in the above two experiments, and the colouring matter, when dried, but ſmall in quantity, I evaporated the mother-water of ſoda phoſphorata to a thick pellicle, and a deliqueſcent ſalt was produced: the remaining liquor was precipitated with a ſolution of common alum and martial vitriol, made with the proportions above mentioned. A precipitate, not ſo light as the two others, and in appearance leſs in quantity, was produced, but which, when waſhed and dried, yielded about the ſame weight as the others: it was of a paler blue than the firſt production, but of a bright colour.

This has not yet been tried as a water-colour, nor have I received any account of their being uſeful oil-colours, although I have given ſome of each of them to different painters, as alſo a portion of the next preparation.

Thinking that the aluminous earth was the reaſon of the ſpungineſs of the colours, when uſed as water-colours, I thought, by precipitating the mother-water of ſoda phoſphorata with a martial ſolution alone, it might produce a colour free from that ſpungineſs complained of; I therefore added to the mother-water above mentioned a ſaturated ſolution of martial vitriol, and a very copious precipitate was formed, but of a leſs beautiful colour than either the firſt or third. The

precipitate

precipitate was very light, and required ſome length of time to ſettle; it was waſhed till perfectly taſteleſs, and, although it occupied much ſpace, being very expanſive, it yielded a leſs proportion of dry colour than either of the former proceſſes, and was not ſo deep a blue as No. 1.

As this laſt colour, when dried, had a little browniſh tinge on its ſurface, I concluded it proceeded from its having ſome ochry matter mixed with it; to free it from which, I added a little oil of vitriol to a ſmall portion of it, and the whole became of a dirty green, which, on being poured into water, turned of a deep blue. This was well waſhed, to free it from all acidity; but the colour did not appear to be improved.

In order to examine whence this colouring matter proceeded, the following experiments were made.

Experiment I. Some pure ſoda phoſphorata was diſſolved, to which was added a portion of the aluminous and martial ſolution. A dirty white coagulum was formed, which, by adding more of the precipitating liquor, was re-diſſolved entirely.

Experiment II. To ſome of the ſame ſolution of ſoda phoſphorata was added a ſolution of martial vitriol. A ſimilar coloured coagulum appeared, of which, upon ſurcharging it with the latter

ſolution, the greateſt part was re-diſſolved, and the remainder continued unchanged in colour.

Experiment III. With ſal ſodæ diſſolved in water, the aluminous and martial ſolution precipitated a dirty white colour, which being overcharged with the precipitating liquor, part was re-diſſolved, and what remained was not altered in colour.

Experiment IV. Some of the ſame ſolution of ſal ſodæ was precipitated with a ſolution of vitriolated iron. A very large quantity of brown precipitate was produced, which, being overcharged with the ſolution of iron, effervesced much, and the precipitate was re-diſſolved.

This experiment was ſome time afterwards repeated, with another ſolution of ſal ſodæ, and the ſolution of vitriolated iron, when a ſimilar coloured precipitate was produced; but, being overcharged with the latter ſolution, only part of the precipitate was re-diſſolved, and there was no alteration of colour.

Experiment V. The mother-water of ſal ſodæ, precipitated with the aluminous and martial ſolution, gave at firſt a dirty brown colour, which did not diſſolve, but, upon ſuperſaturation, was changed to a pale blue colour: this was only from one parcel of the mother-water of ſal ſodæ; for, on trying various other mother-waters of ſal ſodæ, very different productions were obtained.

tained. From ſome, a dirty brown; from others, a dirty white; from others, a grey. The beſt colour that was produced is marked No. 3. As the barilla that is brought from Spain is very unequal in its ſtrength and quality, the difference of the precipitates is not much to be wondered at.

Experiment VI. With the ſame mother-water as mentioned in the fifth experiment, and a ſolution of martial vitriol, much the ſame effect was produced, only a leſs copious precipitate, and of a paler colour; but, in ſeveral other trials, on various other mother-waters of ſal ſodæ, a brown coloured precipitate was generally produced.

Experiment VII. The pure mineral alkali from the Eaſt Indies, diſſolved in water, and precipitated with the aluminous and martial ſolution, formed a dirty white precipitate, which, being overcharged with the precipitating liquor, efferveſced very much: part of the precipitate was re-diſſolved, and the remainder retained its colour.

Experiment VIII. To the ſame ſolution of mineral alkali, mentioned in the ſeventh experiment, was added a ſolution of vitriolated iron. A large quantity of olive-green coagulum appeared. Upon ſuperſaturating it, a great efferveſcence was excited, and the whole of the coagulum was re-diſſolved, yielding a browniſh-green

green diaphanous liquor; but, upon, ſtanding all night in the glaſs-veſſel, a browniſh-green precipitate fell down.

Experiment IX. The acid of phoſphorus was added to the aluminous and martial ſolution, and it gave a pale white precipitate.

Experiment X. The acid of phoſphorus being added to the ſolution of vitriol of iron, no decompoſition took place.

It appears that, from the mother-water produced from the combination of the phoſphoric acid and mineral alkali, a blue colour is *always* obtained by means of a martial ſolution; but that from the mother-water of ſal ſodæ it is uncertain, and what is produced is of a pale colour. That this fact might be more ſatisfactorily aſcertained, the mother-waters of ſal ſodæ that were uſed, were thoſe from which the ſalt had been extracted to make the ſoda phoſphorata, whoſe mother-waters were tried in theſe experiments.

It is true alſo, that the mother-water of tartarized natron will ſometimes yield a Pruſſian blue, but not always, and, whenever it does, it is generally pale-coloured; but, in all the experiments made with the phoſphorated alkaline mother-waters above related, a deep blue colour has been produced, except in the ſingle one made with rock-alum; for the other operations have been

been repeated, and the reſults have been uni form.

The acid of phoſphorus has been tried with the two precipitating liquors, and no blue colour was produced. It therefore remains to account how this blue colour ſhould be continually produced by the combination above mentioned, eſpecially as the phoſphoric acid was obtained from bones burned to a perfect whiteneſs, which might be expected to deſtroy the tinging principle.

Some of the beſt Pruſſian blue that could be purchaſed was added to the ſtrong vitriolic acid. It was changed to a green colour, but much paler than that produced from the colour precipitated by the martial ſolution, as before related, by adding the acid of vitriol to it; but, on diluting the Pruſſian blue digeſted in the vitriolic acid, with water, a large quantity of white powder was perceived, which evidently muſt be the earth of alum. Upon farther diluting and ſtirring the mixture, it readily mixed with the tinging matter, and appeared uniformly blended therewith.

A portion of the blue colour, No. 1, was likewiſe digeſted with ſtrong vitriolic acid. It was changed to a darker green colour than in the laſt-mentioned proceſs, but, on diluting it with water, it changed uniformly to blue. On digeſting ſome of No. 2 with the vitriolic acid,

there was a ſeparation when the mixture was diluted with water. At firſt, the mixture was of a deeper green than that of the Pruſſian blue digeſted in vitriolic acid; and, upon diluting it, the liquor, at firſt, altered but little; but, in the ſpace of half a minute, it became of a deeper blue than the original, and a large quantity of a dirty white-coloured matter was ſeparated.

It alſo appears, that there is very little difference between the pure mineral alkali brought from the Eaſt Indies and the beſt Spaniſh barilla, when it is freed as much as poſſible from common ſalt.

From the deep colouring matter ſeparating on the dilution of Pruſſian blue digeſted with vitriolic acid, by adding water to it, query, whether a much finer blue might not be produced, by pouring off that blue liquor from the white powder, and edulcorating it.

VII. *Farther Remarks on the Cause of the Smut in Wheat. By Mr.* Joseph Wimpey, *of North Bockhampton.*

From the Letters and Papers of the Bath and West-of-England Society for the Encouragement of Agriculture, &c.

In a former letter on this subject *, I mentioned my having then more experiments on foot, with a view to the farther investigation of the cause of the smut in wheat. It is true, that although those experiments were numerous, they have afforded no new discovery, that is, nothing different from the result of those I formerly related; yet I think they may be of great use, as they may serve to corroborate and confirm the opinion I maintained, respecting the cause of an evil so extensive and alarming.

To give a circumstantial relation of each experiment, would be both tedious and unimportant; suffice it then to say, they were made with sound

* The letter here referred to is printed in our ninth volume, page 392.

corn picked out of ſmutty ears, ſet at different times, and on different ſoils; prepared by ſteeping in different liquors; ſome in ſimple water, and ſome without any preparation at all. The reſult was, that not one ſmutty ear was to be found in any of the experiments.

It is true indeed that the wheat of laſt year was in general pretty free from ſmut; but, if the cauſe of the evil originate in the ſeed, and not in the ſeaſon, the produce of the above experiments would have been juſt as liable to the ſmut, (being taken from ſmutty ears,) as in any other ſeaſon whatever.

Some of the ſeed of theſe experiments was ſteeped in a ſolution of ſalt; ſome in a lixivium of wood-aſhes; ſome in a ſolution of ſugar; ſome in ſtrong ale; ſome in clear water; and ſome were ſet dry, as they came from the ear; but at harveſt there was no perceptible difference, either as to ſtrength of plants, or ſoundneſs and plumpneſs of grain. I could not perceive that any advantage had been gained by any of the infuſions made uſe of, excepting that the corn from the unwaſhed ſeed abounded much more with weeds, than that from the ſeed which had been ſteeped and waſhed, which was rather contrary to what I had hoped and expected, from a former experiment of ſteeping, which ſeemed to promiſe an increaſe of fertility and produce.

There

There is one experiment, however, which I beg leave to relate a little more particularly:

The firſt experiment I made on ſmutty wheat was four years ago, on ſome ſound corns I picked out of a ſmutty ear of white wheat, ſaid to be originally from Canada. The corn from this ſeed I have continued to plant ever ſince, to try if there would be any return of the original taint, or ſymptom of that diſorder. The produce ever ſince has been not only free from it, but the grain remarkably plump and fine. In the harveſt of 1790 the whole of it was nearly deſtroyed by birds. I did not ſave a tenth part of it, and that from the weakeſt and lateſt ripe ears; however, I ſaved all I could, and planted it in my garden the Auguſt following. To prevent a like devaſtation from the birds, I had part of a ridge dug in the middle of a field of wheat reſerved for the purpoſe, and, in February following, tranſplanted it there in rows, at 9 inches diſtance, and 6 inches apart in the rows. When the plants were about a foot high, they were completely eat down by the hares, and I thought them deſtroyed irrecoverably; but they ſoon ſhot up again, and at harveſt produced as long and fine ears, and as plump ſound good corn, as I ever ſaw. The produce was at the rate of $37\frac{1}{2}$ buſhels to the acre: the weight of the buſhel 72 pounds; 9 gallons by meaſure. The ſoil was a poor, binding, loamy

fand, which, if undifturbed, foon grows moffy. It had borne fix drilled crops in fucceffion, four of them wheat, without any manure whatever.

From this, and fome other obfervations I have made on tranfplanted wheat, I am convinced no mode of practice would equal tranfplanting, as to quantity of produce; but, from the great labour and expence, and number of hands it would require, that mode of cultivation, on a large fcale, is abfolutely impracticable, and therefore not to be thought of. But, to return to our fubject.

Some who favour the opinion, that the caufe of the fmut is from the depravity of the feed, have obferved, that "when two adjoining fields have "begun their blooming at the fame time, but "belonging to different owners, and therefore "fown with different feed, one fhall be almoft "free from fmut, and the other greatly infefted "with it. This cannot be owing to the atmo-"fphere, (fay they,) for they have both the "fame; what then can be faid to this, by "thofe who fuppofe the fmut is owing to the "unfavourablenefs of the weather at the time of "blooming?"

I anfwer, the objection feems calculated to give countenance to their opinion, but it by no means enters far enough into the bufinefs to inveftigate the truth; for, though the fields are contiguous, and their atmofphere equally fo, correctly and truly

truly ſpeaking, the latter may be no more the ſame than the former, probably, in reſpect to quality, far more different: When we ſpeak of the atmoſphere, we mean, not only the circumambient air, but every principle, of whatever nature or kind, that floats in it. Theſe are ſometimes of a very malignant nature, and extend far and near, but are frequently confined to a kind of ſtream or current, like water in a river, and affect thoſe objects only which ſtand in their way, and obſtruct their paſſage. It is not very uncommon to ſee trees and plants blighted and blaſted on one ſide, while the other ſhews not the leaſt ſign or mark of being injured. Such partial ſufferings happen at times to almoſt every field, and every kind of plant it bears.

It hath many times fallen within my obſervation, that the eaſt and ſouth ſides of a field of wheat have been exceedingly ſmutty, when the north and weſt, and the other parts of the field, have been little affected by it. But, farther, we have frequently found both ſound and ſmutty ears growing from the ſame root; and, what is ſtill more, ſound and ſmutty grains, at the ſame time, in one and the ſame ear. To imitate our objectors then, and attempt to obviate one difficulty by ſtarting another, will they permit me to aſk what they can ſay to this? If ſmutty ſeed infallibly produces a ſmutty crop, as they maintain,

what produces the ſound ears which grow out of the ſame root with the ſmutty ears, and the ſound grains which are found in the ſame ear with the ſmut-balls?

This ſingle obſervation clearly refutes their whole argument. It is an eſtabliſhed maxim in phyſics, "that the ſame *cauſes* infallibly pro-"duce the ſame *effects*," and, were it not ſo, human knowledge of any future event would be an impoſſible thing; for, this is the principle which directs actions to ends; without it, intention or deſign would have no object. To ſay then, that both ſound and ſmutty grain proceed from the ſame root, which root is vitiated and depraved, yet is the efficient cauſe of both, is as palpable a contradiction as to aſſert, that good wholeſome blood, and a putrid, malignant, poiſonous ichor, may be taken from the ſame vein, at one and the ſame moment.

It is univerſally admitted, that the ſmut moſtly abounds in cold, wet, inclement ſeaſons. If the ſmut then, as theſe gentlemen think, proceed from corrupt or vitiated ſeed, we ſhould find moſt of it the year following any year in which it much abounded; for, if it proceed from ſmutty ſeed, as its ſole cauſe, which they maintain, certainly every ſucceeding crop would increaſe in ſmut, as the quantity of ſmutty ſeed ſown would, in ſome degree at leaſt, be in proportion to the quantity of ſmut

ſmut in the crop of the year preceding; therefore, if this were the caſe, the ſmut would annunually increaſe, till in a very few years we ſhould have no wheat free from ſmut, that is, it would be all ſmut, and we ſhould have no wheat at all; for ſmut-balls contain nothing but an effete ſtinking powder, totally deſtitute of every principle of life, and therefore never vegetate at all. But this is ſo far from being the caſe, that a very ſmutty year is often ſucceeded by one that has little if any ſmut. This generally happens as often as a damp, cold, inclement ſeaſon is ſucceeded by one that is warm, dry, and favourable to the growth and ripening of grain.

In ſhort, it is not eaſy to enumerate the arguments that might be adduced, in ſupport and confirmation of the opinion here advanced: I ſhall therefore content myſelf with the recital of the two recent caſes following.

In the year 1790, a near neighbour of mine, an intelligent farmer, in a large way of buſineſs, procured a ſample of very fine, clean, ſound, wheat, of which he purchaſed enough to ſow a large field: the reſt of his land he ſowed with wheat of his own growth. From the ſeed he had purchaſed, he hoped to reap enough good corn to ſupply him with ſeed for his whole crop the following ſeaſon, but at harveſt how great was his diſappointment! The produce of his fine ſeed turned

turned out very ſmutty; whereas the crop from the ſeed of his own growth had little if any ſmut in it.

Another farmer, who lived about a mile from me, being rather in low circumſtances, was induced to ſow, the ſame ſeaſon as above, ſome very ſmutty wheat he had by him, it not being convenient to purchaſe good clean ſeed; but, very fortunately for him, his crop proved as clean and as good as any in the neighbourhood, having very little if any ſmut in it. Theſe caſes are far from being ſingular, for many ſuch have come to my knowledge.

Now, if any advocate for the opinion that the ſmut proceeds from ſeminal corruption or depravity, will account for the poſſibility of theſe facts conſiſtently with his own principles, I will be one of the firſt to vote him a ſtatue to perpetuate his fame for inimitable ſkill in the ſolution of difficulties.

VIII. *Observations on the fundamental Property of the Lever; with a Proof of the Principles assumed by* Archimedes, *in his Demonstration. By the Rev.* Samuel Vince, *A. M. F. R. S.*

From the Philosophical Transactions of the Royal Society of London.

THE want of a demonstration of the property of the lever, upon clear and self-evident principles, has justly been considered as a great desideratum in the science of mechanics, as the most important parts of that branch of natural philosophy are founded upon it. Archimedes was, I believe, the first who attempted it. He supposes, that if two equal bodies be placed upon a lever, their effect to turn it about any point is the same as if they were placed in the middle point between them. This proposition is by no means self-evident, and therefore the investigation which is founded upon it has been rejected, as imperfect. Huygens observes, that some mathematicians, not satisfied with the principle here taken for granted, have, by altering the form of the demonstration, endeavoured to render its defects less sensible, but without success. He then attempts

attempts a demonſtration of his own, in which he takes for granted, that if the ſame weight be removed to a greater diſtance from the fulcrum, the effect to turn about the lever will be greater. This is a principle by no means to be admitted, when we are ſuppoſed to be totally ignorant of the effects of weights upon a lever at different diſtances from the fulcrum. Moreover, if it were ſelf evident, his demonſtration only holds when the lengths of the arms are commenſurable. Sir Iſaac Newton has given a demonſtration, in which it is ſuppoſed, that if a given weight act in any direction, and any radii be drawn from the fulcrum to the line of direction, the effect to turn the lever will be the ſame, on whichever of the radii it acts. But ſome of the moſt eminent mathematicians ſince his time have objected to this principle, as being far from ſelf-evident; and, in conſequence thereof, have attempted to demonſtrate the propoſition upon more clear and ſatiſfactory principles. The demonſtration by Mac Laurin, as far as it goes, is certainly very ſatiſfactory; but, as he collects the truth of the propoſition only from induction, and has not extended it to the caſe where the arms are incommenſurable, his demonſtration is imperfect. The demonſtration given by Dr. Hamilton, in his Eſſays, depends upon this propoſition, that when a body is at reſt, and acted upon by three forces,

they

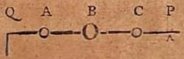
they will be as the three ſides of a triangle parallel to the directions of the forces. Now this is true, when the three forces act at any point of a body: whereas, conſidering the lever as the body, the three forces act at different points, and therefore the principle, as applied by the author, is certainly not applicable. If, in this demonſtration, we ſuppoſe a plane body, in which the three forces act, inſtead of ſimply a lever, then the three forces being actually directed to the ſame point of the body, the body would be at reſt. But, in reaſoning from this to the caſe of the lever, the ſame difficulties would ariſe as in the proof of Sir Iſaac Newton; and, admitting that all other objections could be removed, the demonſtration fails when any two of the forces are parallel. Another demonſtration is founded upon this principle, that if two non-elaſtic bodies meet with equal quantities of motion, they will, after impact, continue at reſt; and hence it is concluded, that if a lever which is in equilibrio be put in motion, the motions of the two bodies muſt be equal, and therefore the preſſures of theſe bodies upon the lever at reſt, to put it in motion, muſt be as their motions. Now, in the firſt place, this is comparing the effects of preſſure and motion, the relation of the meaſures of which, or whether they admit of any relation, we are totally unacquainted with. More-

over, they act under very different circumftances; for, in the former cafe, the bodies acted immediately on each other, and in the latter they act by means of a lever, the properties of which we are fuppofed to be ignorant of. When forces act on a body, confidered as a point, or directly againft the fame point of any body, we only eftimate the effect of thefe forces to move the body out of its place, and no rotary motion is either generated, or any caufes to produce it confidered in the inveftigation. When we, therefore, apply the fame propofition to inveftigate the effect of forces to generate a rotary motion, we manifeftly apply it to a cafe which is not contained in it, nor to which there is a fingle principle in the propofition applicable. The demonftration given by Mr. Landen, in his Memoirs, is founded upon felf-evident principles, nor do I fee any objections to his reafoning upon them. But, as his inveftigation confifts of feveral cafes, and is befides very long and tedious, fomething more fimple is ftill much to be wifhed for, proper to be introduced in an elementary treatife of mechanics, fo as not to perplex the young ftudent, either by the length of the demonftration, or want of evidence in its principles. What I here propofe to offer will, I hope, render the whole bufinefs not only very fimple, but alfo perfectly fatisfactory.

The

The demonſtration given by Archimedes would be very ſatisfactory and elegant, provided the principle on which it is founded could be clearly proved; *viz. that two equal powers at the extremities, or their ſum at the middle of a lever, would have equal effects to move it about any point.* Now, that the effects will be the ſame, ſo far as reſpects any *progreſſive* motion being communicated to the lever, when at liberty to move freely, is ſufficiently clear; but there is no evidence whatever, that the effects will be the ſame to give the lever a *rotary* motion about any point, becauſe a very different motion is then produced, and we are ſuppoſed to know nothing about the efficacy of a force at different diſtances from the fulcrum to produce ſuch a motion. Beſides, the two motions are not only different, but the *ſame* forces are known to produce *different* effects in the two caſes; for, in the former caſe, the two *equal* powers at the extremities of the arms produce *equal* effects in generating a *progreſſive* motion; but, in the latter caſe, they do *not* produce *equal* effects in generating a *rotary* motion. We cannot therefore reaſon from one to the other. The principle, however, may be thus proved.

Let A C, be two equal bodies placed on a ſtraight lever A P, moveable about P; biſect A C in B, produce P A to Q, and take



BQ=BP, and suppose the end Q to be sustained by a prop. Then, as A and C are similarly situated in respect to each end of the lever, that is, AP=CQ, and AQ=CP, the prop and fulcrum must bear equal parts of the whole weight; and therefore the prop at Q will be pressed with a weight equal to A. Now, take away the weights A and C, and put a weight at B equal to their sum; then the weight at B being equally distant from Q and P, the prop and fulcrum must sustain equal parts of the whole weight, and therefore the prop will now also sustain a weight equal to A. Hence, if the prop Q be taken away, the moving force to turn the lever about P, in both cases, must evidently be the same; therefore, the effects of A and C upon the lever, to turn it about any point, are the same as when they are both placed in the middle point between them: and the same is manifestly true if A and C be placed without the fulcrum and prop. If, therefore, AC be a cylindrical lever of uniform density, its effect to turn itself about any point will be the same as if the whole were collected into the middle point B; which follows from what has been already proved, by conceiving the whole cylinder to be divided into an infinite number of laminæ, perpendicular to its axis, of equal thicknesses.

The

The principle, therefore, aſſumed by Archimedes, is thus eſtabliſhed upon the moſt ſelf-evident principle, that is, that *equal* bodies at *equal* diſtances muſt produce *equal* effects; which is manifeſt from this conſideration, that when *all* the circumſtances in the cauſe are equal, the effects muſt be equal. Thus the whole demonſtration of Archimedes is rendered perfectly complete, and at the ſame time it is very ſhort and ſimple. The other part of the demonſtration we ſhall here inſert, for the uſe of thoſe who may not be acquainted with it.

Let X Y be a cylinder, which biſect

B A Z C
X———————Y in A, on which point it would manifeſtly reſt. Take any point Z, and biſect Z X in B, and Z Y in C; then, from what has been proved, the effect of the two parts Z X, Z Y, to turn the lever about A, is the ſame as if the weight of each part were collected into B and C reſpectively; which weights are manifeſtly as Z X, Z Y, and which therefore conceive to be placed at B and C. Now $AB = AX - XB = \frac{1}{2}XY - \frac{1}{2}XZ = \frac{1}{2}YZ$; and $AC = AY - YC = \frac{1}{2}XY - \frac{1}{2}ZY = \frac{1}{2}XZ$; conſequently, $AB : AC :: \frac{1}{2}YZ : \frac{1}{2}XZ :: YZ : XZ ::$ the weight at C : the weight at B.

The property of the ſtraight lever being thus eſtabliſhed, every thing relative to the bent lever immediately follows.

IX.

IX. *Differtation on painting in Oil, in a Manner fimilar to that practifed in the antient Venetian School. By Mr.* TIMOTHY SHELDRAKE, *of the Strand.*

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

The greater Silver Pallet was voted to Mr. SHELDRAKE, for this Differtation.

THE method of painting practifed in the Venetian School, I conceive to have been as follows:

The cloth was primed with colours in diftemper, of a brownifh hue, fuch as would properly enter into the darkeft parts of the picture: the moft tranfparent colours are the propereft. I believe umber was moft generally ufed, broken with red, yellow, or blue, according to the tint intended to be produced, and diluted with chalk, or whiting, to the proper degree of ftrength. Upon the ground fo prepared, the fubject was correctly

correctly drawn with umber, pure, or mixed with lake, blue, or black: and, with the ſame colours, thoſe ſhadows that were darker than the ground were then painted in.

The artiſt then painted the lights with *pure white*, in a ſolid body, where the light was brighteſt, or where the full effect of colour was to be produced; and, where the demi-tints were afterwards to be, ſcumbling it thinner by degrees, till it united with the ſhadows.

In this manner, the chiaro-oſcuro was finiſhed as much as poſſible, and the local colour of every object in the picture glazed over it. All the colours uſed in this part of the work were ground in oil, which was abſorbed into the ground; the picture remaining flat, ſomething like a picture in water-colours, or crayons: it was then varniſhed, till ſaturated with varniſh, and the full of every colour brought out. The picture was then complete.

Upon the moſt ſuperficial view of this proceſs, it will be evident that a picture painted by it is, as to all viſible properties, a varniſh picture; for the ſmall quantity of oil that had been uſed ſunk into the ground, and never could riſe again to be hurtful; while the varniſh, being laid on after the colours, gave them all the brilliancy and durability they could derive from that vehicle,

 without

without being liable to the objections that are made to painting in varnifh, fuppofing it to be ufed in the fame manner as oil is in painting with oil. It is true, that this mode of painting is itfelf liable to fome objections; thefe I have endeavoured to obviate, and fhall therefore mention hereafter. Here it may be obferved, that, as any varnifh may be ufed, it is to this circumftance we muft attribute the different degrees of durability, in pictures of the Venetian School. I have feen fome that would refift the moft powerful folvents, while others were deftroyed by the weakeft; though all poffeffed the apparent properties that diftinguifh the Venetian pictures from all others.

As I do not pretend to degrade painting to the rank of a mechanical art, that may be infallibly practifed by a receipt, I fhall be permitted to obferve, that this was the general fyftem of the Venetian fchool, which I have feen varioufly modified, in the works of different artifts of that, as well as of the Flemifh School, which is derived from it. It is fufceptible of an almoft infinite number of modifications, in proportion to the talents or judgment of, and the objects to be painted by, the artifts who may adopt it. This being the cafe, if it is proved by experiment, that effects fimilar to thofe of the Venetian pictures may be

produced

produced by this method, and that the ſyſtem has a ſtrong tendency to produce that brilliancy and harmony of colouring that is ſo much admired, with more certainty and facility than thoſe qualities can be obtained by any other mode of painting, I hope my caſe will be proved to the ſatisfaction of the Society.

I once aſked Sir Joſhua Reynolds, by what circumſtances, in the management of a picture, he thought the harmony of colouring was to be produced. He replied, an unity of light and an unity of ſhadow ſhould pervade the whole. He explained to me the difficulty of reducing the various colours of all the objects that may be included in a picture, and the various modifications of thoſe colours, to the ſimple harmonious ſtate he deſcribed, and illuſtrated what he had ſaid by this ſimile. "A picture, to poſſeſs harmony of colouring, ſhould look as if it was painted with one colour, (ſuppoſe umber and white,) and, when the chiaro-oſcuro was complete, the colour of each object ſhould be glazed over it."

This obſervation, from ſuch authority, was impreſſed with peculiar force on my mind; and, if I can retrace its operations on a ſubject which has ſo long engaged my attention, I ſhould ſay Sir Joſhua's obſervation was the clue that guided

me through all my experiments, and, I hope, will enable me to prove, that the beautiful and ſimple practice which he ſuggeſted, as a ſimile, was literally the practice of that ſchool upon whoſe works his ideas of colouring were founded. At the ſame time I may obſerve, that the fact ſeems to have eluded his obſervation, or he would not have uſed it as a compariſon, to ſimplify his deſcription of a practice which he thought both difficult and complex.

In the Newtonian doctrine of light and colours, it is believed that all colours are inherent in light, and are rendered viſible by the action of various bodies, which reflect particular rays, and abſorb the reſt. Without diſputing the truth of this doctrine, it is to be obſerved, that a painter muſt conſider the objects he repreſents as being analogous to the materials he uſes to repreſent them; and, in this view of the ſubject, colour is to be conſidered as a property inherent in bodies, which is rendered viſible by the contact of light, (a colourleſs, or at leaſt a mono-coloured ſubſtance,) and ſhadow as the mere privation of light.

A picture may repreſent either a group of figures, or other objects, in a room, or any objects in the open air: whatever the ſituation may be, it repreſents certain objects in a given ſpace, poſſeſſing individually their peculiar colours, and generally

generally expoſed to the operations of light. The quantity of light each can receive muſt depend upon its form, and its poſition reſpecting that part whence the light comes; for, in proportion as other parts recede from the light, the ſhadow becomes viſible: yet ſhadow is nothing but privation of light, and privation of colour, in proportion as the light is diminiſhed. Some attention to theſe circumſtances will, perhaps, enable us to demonſtrate the truth of Sir Joſhua's poſition.

If a globe of one colour be expoſed in a painter's room, properly darkened, that part which is neareſt the light will partake of its colour; the next part will ſhew the true colour of the object: that which firſt recedes from the light will be a little obſcured, the next a little more, and ſo on, progreſſively, till that part which is fartheſt from the light will loſe its colour, and appear equally dark with the ſhadieſt part of the room. Now we know this globe is of one uniform colour; the variations we ſee in different parts of it are only deceptions, occaſioned by the acceſſion of light in ſome parts, and the privation of it in others.

What is true of this one object and its parts, would be equally true of any number of objects, whatever their colours or relative ſituations might

be:

be: if they were placed together in the ſame room, each would poſſeſs its own individual colour; each would partake of the general light, in proportion to its ſituation, and of the general darkneſs, in proportion as it recedes from the light. All this may be eaſily conceived; but the difficulty is, (and, in the ordinary modes of painting, it is a ſerious one,) to repreſent ſuch objects with the appearance of truth, and preſerve the harmony neceſſary to conſtitute a whole. The Venetian painters however, by whatever means they obtained their knowledge, diſcovered a method ſo ſimple, that perhaps no other can produce ſuch brilliant effects, and undoubtedly not with facility and certainty at all comparable with theirs.

TO BE CONCLUDED IN OUR NEXT.

X. *Obſervations on the Effect of Mordants in dying Cotton red.* By J. A. Chaptal.

FROM THE *ANNALES DE CHIMIE.*

In dying cotton of a fine red colour, by means of madder, it is ſtill the cuſtom, as in certain medical preparations, to adhere ſtrictly to the moſt whimſical and extraordinary preſcriptions, leſt any change in the proceſs ſhould produce an alteration in the reſult.

A month's work is hardly ſufficient to complete all the operations ſuppoſed indiſpenſable for obtaining the fine red colour, called Adrianople or Turkey red. In the proceſs for which are ſucceſſively employed the following ingredients, *viz.* barilla, oil, galls, ſumach, alum, blood, the gaſtric juice, madder, ſoap, ſolution of tin in *aqua regia*, and other ſubſtances.

The true means of ſimplifying this proceſs is not by working at random, and trying, without rules and principles, methods different from thoſe at preſent made uſe of. That mode of proceeding leads very rarely, and always ſlowly, to ſuc-

ceſsful

cefsful refults. I know but one way of making any progrefs in the arts, namely, by reducing all the operations to fimple principles; by this means we obtain fixed points, from which we may take our departure, and to which we may refer the refults of our labours. Chemiftry is now in a fufficiently advanced ftate to furnifh thefe firft bafes; it is only neceffary to eftablifh them, and they will become, in the hands of the workman, what formulæ are in the head of the mathematician. I fhall give one example of this, by fubmitting to chemical principles, the action of the three principal mordants employed in dying cotton red, *viz.* oil, galls, and alum.

It is well known that cotton will not take a permanent red dye from madder, except it has firft been properly impregnated with oil. The red given to cotton by printing is far from poffeffing the fame degree of fixity, fince it cannot fupport the operation of brightening by means of barilla.

This preliminary preparation is given to cotton, by forming (without heat) a foapy liquor, by the combination of oil with a weak folution of barilla.

This alkaline lixivium is of no ufe but to dilute and divide the oil, fo as to give the workman the power of applying it, with eafe, to every part of the cotton, in an equal manner.

I have

I found that potafh produced the fame effects as barilla; a circumftance which is, in my opinion, deferving of fome attention, becaufe, in thofe parts where barilla is fcarce and dear, its place may be fupplied by potafh.

It follows, from this principle, that all kinds of barilla, or of oil, cannot be employed indifferently.

In order that the barilla fhould be fit for the purpofe, it is neceffary that it fhould be in a cauftic ftate, and that it fhould contain but a fmall quantity of fea-falt.

It muft not be rendered cauftic by quick-lime, becaufe it then gives the colour a brown hue; its caufticity muft therefore be produced by calcination.

Barilla which is rendered mild by fixed air, and that which has much fea-falt mixed with it, unite very imperfectly with oil; confequently, old barilla in an efflorefcent ftate, and the impure barilla of our climate, cannot be ufed in the dye here treated of.

The choice of the oil is as effential as that of the barilla.

In order that an oil fhould be good for this purpofe, it muft be capable of uniting very perfectly with the folution of barilla, and of continuing permanently in a ftate of complete combination.

 The

The oil moſt fit for the purpoſes of dying, is not fine oil; on the contrary, it is that which contains a large portion of extractive principle.

The former (fine oil) does not preſerve its ſtate of combination with the barilla: it alſo requires a ſtronger ley; a circumſtance which prevents the dyer from graduating properly his ſubſequent operations.

The other kind of oil makes a combination which is thicker and more durable; it alſo requires but a weak ley, of one or two degrees of ſtrength.

The neceſſity of producing a very intimate and perfect combination of the oil with the barilla, will be readily perceived, by reflecting, that the ley of barilla (as was before mentioned) is only made uſe of for the purpoſe of dividing and diluting the oil, ſo that it may be applied equally to all parts of the cotton. From this principle it follows, that if the oil is not well mixed, the cottons which are dipped in this mordant, will take the oil unequally, and, conſequently, the colour given to them by dying will not have an uniform appearance.

Hence it is, that the workman conſiders the ſecret of producing an uniform and rich colour, to conſiſt merely in chuſing ſuch oil, and ſuch barilla, as will anſwer his purpoſe.

It

It follows, alſo, from theſe principles, that there ſhould be an exceſs of oil, and not merely as much as is requiſite for the ſaturation of the barilla; for, in the latter caſe, ſome of the oil would quit the cotton, when it was waſhed, and the colour would remain dry.

When the cotton is properly impregnated with oil, it is made to undergo the operation of *galling*. In this operation, galls produce ſeveral advantages. Firſt, the acid they contain decompoſes the ſoapy liquor with which the cotton is impregnated, and fixes the oil upon it. Secondly, the animal nature of the galls gives the cotton a diſpoſition to receive the colouring principle. Thirdly, the aſtringent principle unites to the oil, and forms with it a compound which grows black as it dries, which is almoſt inſoluble in water, and which has a very ſtrong affinity with the colouring principle of the madder.

This laſt combination may be obtained, and an opportunity given of inveſtigating its properties, by mixing a decoction of galls with a ſolution of ſoap.

From the above principles it follows, Firſt, that other aſtringents, in whatever proportion they are employed, cannot be uſed inſtead of galls. Secondly, that the decoction of galls ſhould be made uſe of as hot as poſſible, in order that the decompoſition may be ſudden and complete.

 Thirdly,

Thirdly, that the galled cotton ſhould be dried quickly, to prevent its turning black, which would diminiſh the brightneſs of the red colour meant to be given to it. Fourthly, that dry weather ſhould be choſen for the proceſs of galling, becauſe wet weather tends to give the aſtringent principle a black colour, and alſo retards the drying. Fifthly, that the cotton ſhould be preſſed with the greateſt care, in order that the decompoſition, about to be produced, may take place equally at every part of its ſurface. Sixthly, that there ſhould be a fixed proportion obſerved, in the quantity of galls and ſoap made uſe of. If the galls predominate, the colour is apt to be black; if the ſoap is in exceſs, that portion of the oil which is not combined with the aſtringent principle becomes uſeleſs, as it is carried off when the ſtuff is waſhed: the colour alſo is more faint.

The third mordant employed in dying cotton red, is alum. This ſubſtance has not only the property of brightening the red colour produced by madder, but it alſo contributes, by its decompoſition, and the fixity of its earth, to give ſolidity to the colour.

In order to judge of the effects produced by alum, in dying cotton red, it is only neceſſary to mix a decoction of galls with a ſolution of alum. The mixture immediately becomes turbid, and a greyiſh

greyiſh precipitate is formed, which, when dried, is inſoluble in water, and in alkalies.

Every circumſtance that happens in this experiment, may be obſerved in the operation of aluming, for the purpoſe of dying. The cotton, when galled, and dipped in a ſolution of alum, or of acetite of alumine, changes its colour, and inſtantly becomes grey. No precipitate appears in the bath, becauſe the precipitation takes place in the ſubſtance of the cotton, in which the products of that operation remain fixed. It muſt, however, be obſerved, that if the ſolution of alum, into which the galled cotton is dipped, is too hot, a certain portion of the galls eſcapes from the cotton, and then the decompoſition of the alum takes place in the bath itſelf; this neceſſarily diminiſhes the proportion of the mordant, and thereby renders the colour leſs rich.

Here then is a combination of three principles, (oil, the aſtringent principle, and the earth of alum,) which ſerves as a mordant in dying red with madder. When theſe principles are uſed ſeparately, they produce neither the ſame fixity, nor the ſame brilliancy in the colour.

This mordant is, undoubtedly, the moſt complicated of any known in the art of dying, and it preſents to the chemiſt a ſpecies of combination very intereſting to inveſtigate.

It is from the exactneſs of this combination, and from the ſkill of the artiſt in making it, that a beautiful colour is to be expected. But, although it may be poſſible, by taking experience for our guide, to conduct ourſelves properly through the labyrinth of theſe numerous combinations, it is very difficult to render them more ſimple and perfect. It is only by reaſoning upon the operations, and calculating the principle and reſult of each of them, that we can be complete maſters of our proceſſes, can correct the errors of them, and can obtain conſtant reſults. Without doing ſo, the practice of the moſt experienced artiſt offers only a diſcouraging alternation of ſucceſſes and failures. It was my view, in the analyſis I have here given of the operation of dying red with madder, (the moſt complicate of all ſuch operations,) to give an example of the aſſiſtance chemiſtry can afford to the arts, when it enlightens them by its prinicples. And I am convinced that the moſt ignorant workman will find, in this ſhort explanation, the principles of his work, and the rules by which he ought to conduct himſelf.

XI. *List of Patents for Inventions, &c.*

(Continued from Vol. IX, Page 432.)

JOHN GREUFELL, of Dulwich, in the county of Surrey, Merchant; for a new mode of applying machinery, in manufacturing copper and tin-plate vessels of every description. Dated October 10, 1798.

SAMUEL ROBERTS, of Park Grange, in the parish of Sheffield, in the county of York, Silversmith and Plater; for a method of making the nozles of candlesticks, of silver, silver-plated, or other metal, in such a manner that the candle may be raised or depressed to any height within the socket, and capable of being easily adjusted, so as to receive, and hold firm, candles of different sizes. Dated October 30, 1798.

WILLIAM SOUTHWELL, of Broad-court, in the Parish of St. Martin's in the Fields, in the county of Middlesex, Musical Instrument maker; for new improvements on the action and construction of piano-fortes, and other musical instruments. Dated November 8, 1798.

WILLIAM

William Chapman, of Newcaſtle-upon-Tyne, Gentleman; for a new method of laying, twiſting, or making ropes or cordage, of any number of yarns or ſtrands, or any number of threads, tarred or untarred, &c. and for which he obtained former letters patent, dated on or about the 13th of September, 1797, and the 6th of March, 1798. Dated November 8, 1798.

Edward Shorter, of Giltſpur-ſtreet, in the city of London, Clock-maker, and William Anthony, of the pariſh of St. John, Clerkenwell, Watch-maker; for a method of eaſing, equalizing, and facilitating, the draught of carriages of every deſcription, and for eaſing the body of carriages of every deſcription, in hanging the ſame; alſo for the more ſecurely fixing tents and marquees, and preventing the inconvenience attending the preſent mode of fixing the ſame, and which invention is likewiſe applicable to other uſeful purpoſes. Dated November 10, 1798.

Jethro Hornblower, of Whitehall, in the pariſh of Kenwyne, in the county of Cornwall, Engineer; for a method of making pattens, (to be worn by women,) by altering the compoſition and clumſineſs of their make, and preventing their frequent breaking, and uneaſineſs to the feet. Dated November 15, 1798.

Printed by Nichols *and* Son, *Red Lion Paſſage, Fleet Street, London.*

REPERTORY OF ARTS AND MANUFACTURES.

NUMBER LVI.

Printed by NICHOLS and SON, Red-Lion-Paſſage, Fleet-Street, London.

XII. *Specification of the Patent granted to Mr.* GABRIEL AUGHTIE, *of Cheapſide, London, Hardwareman; for his Improvement in Coffins, to prevent the Stealing of Bodies from them after Interment; which ſaid Patent has been duly aſſigned to Meſſrs.* JARVIS *and* SON, *Undertakers and Coffin-Makers, Charing-Croſs, and Great Mary-le-bone-Street, the Corner of Welbeck-Street.*

WITH A PLATE.

Dated July 5, 1796.

TO all to whom theſe preſents ſhall come, &c. Now KNOW YE, that I the ſaid Gabriel Aughtie, in compliace with the ſaid proviſo in the ſaid letters patent, do hereby declare, that the

 nature

nature of my ſaid invention, and the manner in which the ſame is to be made, is particularly deſcribed and aſcertained in the plan hereunto annexed, and the following deſcription thereof; that is to ſay: The coffin is to be made of any kind of wood, and bound with ſteel, iron, or any other metal. The ſides are to be curved without ſaw curfs. On the top edge of each ſide are to be three or more boxes, to be made of iron, ſteel, or any other metal, and to be let in on the internal ſide of the coffin, to receive the ſprings fixed to the lid; on the top edge of the head one box, to receive a ſpring; on the top edge of the foot one box, to receive another ſpring. The ſcrews which are to faſten down the lid paſs through an iron or metal plate, with a ſocket, to receive the head, and to prevent its being got hold of with any kind of inſtrument whatever, for the purpoſe of drawing the ſame. The ſcrews are to be placed between each of the ſprings, in number four, ſix, or eight, according to the number of ſprings, and the ſize of the coffin. The lid is alſo to be bound with ſteel, iron, or any other kind of metal, to prevent the ſame from being cut or broke open. The ſcrews above mentioned are not to have a notch on the head, as in the common way, but they are to be divided as deſcribed by the plan and impreſſion in wax hereunto annexed: ſome of the heads are to be divided with two bevils, and

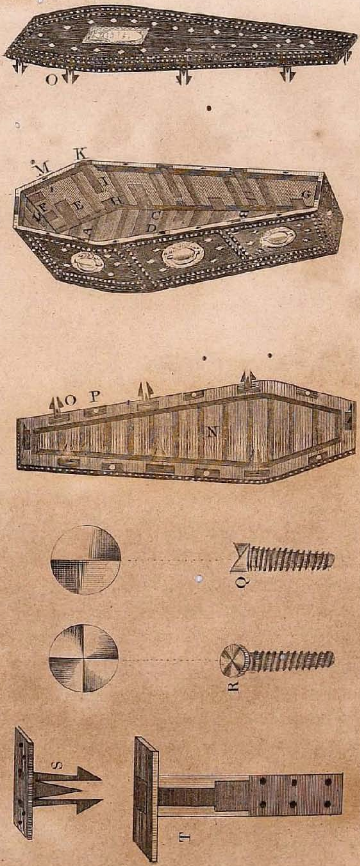
and fome with four; fo that, when they are fcrewed down, it will be impoffible to unfcrew them, as by turning the reverfe way there is no hold for any kind of inftrument. The fcrews to be ufed in faftening on the lid are to be funk about half the thicknefs of the lid; and the holes made in the lid for that purpofe are to be filled, after the fcrews are properly fcrewed down, with plugs of wood, covered or coloured to match the coffin; fo that, when complete, it will not appear as if the fcrews had paffed through the lid. A, B, C, D, (Plate V.) as marked in the plan hereunto annexed, fhew the infide of the bottom of the coffin: the lines drawn acrofs with dots, are plates of iron, fteel, or other metal, put on with fcrews, nails, and rivets. E fhews angle-plates of iron, fteel, or other metal, fixed on with fcrews, nails, and rivets, to prevent the fides, head, and feet, from being feparated from the bottom, in number more or lefs, according to the fize of the coffin. F, G, H, I, fhew the internal part of one fide; the lines drawn acrofs and round the top are plates of iron, fteel, or other metal, put on as above defcribed. K fhews the box to receive the fprings, made of iron, fteel, or other metal, put on with nails, fcrews, and rivets. L fhews the infide of the head, with three angle-plates of iron, fteel, or other metal. In each angle a box is to be fixed, in

 the

the centre of the top edge, to receive the ſpring as before deſcribed; and the foot of the coffin to be completed in the ſame way. M, the large dot, ſhews a hole in the top edge, to receive the ſcrew by which the lid is to be faſtened on. N, the inſide of the lid, with iron, ſteel, or other metal bindings acroſs, as on the bottom: the ſingle line, drawn about one inch from the edge, ſhews a ſlip of iron or ſteel, to prevent its being cut. O, the ſprings, rivetted, or ſcrewed, into a plate of iron, ſteel, or any other metal, and fixed on the lid in like manner. P, plates of iron, ſteel, or other metal, with ſockets, to receive the heads of the ſcrews. Q, R, ſhew the form of the ſcrews to faſten down the lid, as appears alſo by the impreſſion in wax *. S, T, the plan of the boxes and ſprings, as before deſcribed by K and O. In witneſs whereof, &c.

* A repreſentation of that impreſſion is given in our plate, near the heads of the ſcrews.

XIII.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XIII. *Specification of the Patent granted to Mr.* JAMES WELDON, *of Litchfield, in the County of Stafford, Engineer; for his Invention of a certain Machine or Mill for breaking, grinding, and pulverizing hatched or chopped Bark, for Tanning; for breaking, grinding, and pulverizing different Kinds of Wood, and other hard Substances; and for grinding Apples; and which may also be applied to various other useful Purposes.*

WITH A PLATE.

Dated Dec. 22, 1797.

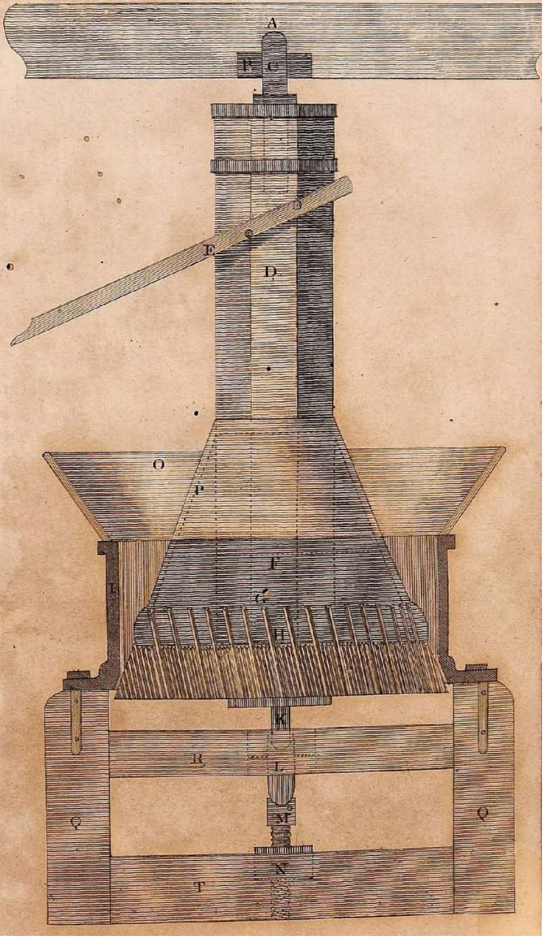
TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said James Weldon do hereby declare, that my said invention is described as follows; that is to say: To explain more fully the principles of my invention, as they may be applied to a mill for breaking, grinding, and pulverizing hatched or chopped bark, for tanning, and other uses; for breaking, grinding, and pulverizing wood, and other hard substances, and for

for grinding of apples; I have annexed a drawing, which the following description is intended to elucidate. A, (Plate VI.) is a piece of timber, connected to the sides of the mill-house, to receive the upper gudgeon of the shaft. B, an iron or metal plate, in which the gudgeon is to work. C, the upper gudgeon, let into the body of the shaft, as shewn by the dotted lines. D, the shaft, which may be of an octangular or any other form. E, the lever or shaft to which the power for working the mill is to be applied, and which may be continued to the length necessary for obtaining sufficient force. F, a cylindrical body, forming the internal part of the mill, which may be composed of cast or wrought iron, or any other proper materials, and may be solid, or hollow, as shewn by the dotted lines on the drawing. G, the upper or breaking teeth, which may be extended higher, as may be found necessary for the different purposes for which the mill is intended. H, the lower, inner, or grinding teeth. I, the hollow external cylinder, containing, on the inside, the outer grinding teeth. This cylinder may be composed of the same materials as the inner cylindrical body, and may be secured by strap-bolts, or other proper fastenings, to the posts Q, Q, of the supporting frame. K, the lower gudgeon, secured to the shaft as the upper gudgeon.

gudgeon. L, the iron, brafs, or other metallic ftep, let folid into the upper crofs rail R, for the purpofe of preventing any lateral motion in the lower gudgeon. M, the regulating fcrew, paffed through the nut N and lower rail T, for raifing or lowering the internal part of the mill, for the purpofe of obtaining a coarfer or finer operation in the works. O, the hopper, affixed on the outer cylinder, to receive the feveral articles that are to pafs through the mill: this hopper may be compofed of wood, or any other proper materials. P, the hollow conical covering over the inner part of the mill, which may be of the fame kind of materials as the hopper O. The frame for fupporting the works confifts of pofts Q, Q, let into the ground at four angular points, to which are connected the lower rail T, and two upper rails R, croffing each other at right angles. Between the pofts are to be fitted, from the under fide of the cylindrical body F to the floor, wire fifters, for the purpofe of feparating the finer from the coarfer parts of the articles paffing through the mill.

Having thus explained the principles of my invention, and the manner in which they may be applied, I obferve, that the materials may be of various qualities, fizes, and fubftances, capable of being applied to the ufes, ftrength,

and purpofes for which they are intended; and that the fize and ftrength of the feveral parts of the machines or mills may be varied, according to the nature and extent of the works to be performed; therefore are not fubject to any precife dimenfions, form, or quality of materials; and may be worked by a horfe or horfes, water-mill or wind-mills, fteam engines, or by any other proper power; and may be applied, not only to the purpofes before mentioned, but likewife will be particularly ufeful for grinding of brill, for foap-boilers and others, clay for making bricks and tiles, and may alfo be applied to many other ferviceable purpofes. In witnefs whereof, &c.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XIV. *Specification of the Patent granted to Mr.* William Row, *of Newcastle upon Tyne, Merchant, for his new-invented* Mineral Lamp-black.

Dated July 14, 1798.

To all to whom these presents shall come, &c. Now know ye, that in compliance with the said proviso, I the said William Row do hereby declare, that my invention consists in obtaining a black colouring matter, which I call *mineral lamp-black*, from pit coal, or any kind of mineral or fossil coal, by preserving the blackest particles of the smoke arising from it when in a state of ignition; which black colouring matter is obtained in the following, or in any other manner by which such smoke can be preserved. A furnace, with a door, is to be erected, of any size or dimensions thought proper, with an upright flue or chimney; and the bottom of the furnace to consist of a grate, open beneath, at the distance of a few yards from the furnace. A house, of any form, with an arched roof or not, at the option of the parties interested, and of a size proportionate to the quantity of lamp-black intended to be collected at any one time, is also to be erected.

 This

This houſe (which, from its forming a recipient for my lamp-black, I call a *blacking-houſe*) has a communication with the upright chimney before mentioned, by means of a horizontal tube or flue, opening into ſuch upright chimney, a few feet above the fire in the furnace. On the top of the upright flue or chimney, and fixed thereto by hinges, is placed a thin iron ſtop-plate or damper, of a ſize ſufficient to cover the aperture, and which can be opened and ſhut at pleaſure, by means of a handle ſuſpended from that ſide of the plate which is oppoſite to the hinges. In the horizontal tube or flue is placed, tranſverſely, another ſtop-plate or damper, which can be drawn out and puſhed in at pleaſure, and by which the communication between the upright chimney and the blacking-houſe can be opened and ſhut; and at one end of the roof of the blacking-houſe is a ſmall aperture or chimney. Now the fire (which is to be made of pit coal, or any other kind of mineral or foſſil coal) being kindled in the furnace, the perſon who attends it, every time he throws in freſh coals, immediately ſhuts the ſtop-plate or damper cloſe upon the top of the upright flue or chimney, and draws out the ſtop-plate or damper in the horizontal tube or flue; by which means, the communication between the upright flue or chimney and the blacking-houſe is left open, and, in conſequence, the ſmoke, which

which is prevented from afcending through the upright flue, by the ftop-plate on the top being fhut, is forced through the horizontal tube or flue into the blacking-houfe, where the blackeft particles fubfide, or attach themfelves to the roof and walls, and the more fubtile fly off through the fmall aperture or chimney at the end of the roof, and through which the rarefied air alfo efcapes. Care muft be taken to keep the communication, between the upright flue or chimney and the blacking-houfe, no longer open than is neceffary to receive the blackeft particles of the fmoke into the blacking-houfe; otherwife the lamp-black will not be of fo pure a quality, as a part of the white afh arifing from the fire, in its more advanced ftate of ignition, will pafs into the blacking-houfe with it. As foon, therefore, as the operator perceives that the blackeft particles of the fmoke are thrown into the blacking-houfe, the ftop-plate or damper in the horizontal tube or flue muft be pufhed in or clofed; and that on the top of the upright flue remain until frefh coals are thrown into the furnace, which is done by the operator at his difcretion. The lamp-black is taken out of the blacking-houfe at the end of every fix or eight days; and, after being dried in a drying-houfe, is packed up for fale. In witnefs whereof, &c.

XV. *Specification of the Patent granted to Mr.* GEORGE BLUNDELL, *of the Pariſh of St. Matthew, Bethnal-Green, in the County of Middleſex, Manufacturer; for his Invention of a Machine for the Purpoſe of ſaving Fuel, and preventing Dirt or Duſt from Fires, which he calls the* Economical Receiver.

WITH A PLATE.

Dated June 1, 1798.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE, that the ſaid George Blundell, in compliance with the ſaid proviſo, doth hereby declare, that the nature of his ſaid invention, and the manner in which the ſame is to be performed, is particularly deſcribed and aſcertained in the following plans and deſcription thereof, *viz.* I take any metal, ſimple or compounded, and ſufficiently hard, and capable of being bent, cut, caſt, or otherwiſe framed or formed

formed into a ſquare, oval, or any other ſhape that may be neceſſary for executing my invention, and ſo as to fit to, and anſwer to, all ſorts of ſtoves, grates, or fire-places; ſome examples of which are ſhewn in the annexed plate, (ſee Plate VII.) repreſenting the receiver in various forms. The back is made to fit the back part of the ſtove, grate, or fire-place.

A. One of the handles for taking away the receiver with its contents.

B. A ſlider, by which it is emptied.

The grating or net-work, delineated on the upper part of the receiver, catches the cinders, and lets fall the aſhes into the receiver below; and which may be made of any kind of wire, worked into any form or ſhape proper for the obvious purpoſe intended; or in plates of metal, either by ſtamping, drilling, piercing, or any other mode of working, leaving a paſſage for the aſhes, and ſeparating them from the cinders.

C, C, ſhews in what manner fenders, of any kind, may be attached to the receiver, either made on purpoſe, or it may be made to ſuit with, and fit any kind of fender.

Fig. 2. ſhews a different way of making the receiver, by ſhortening the grating or netting, whichever may be uſed, and introducing a ſli-

ding-

ding-box, of ſome kind of metal, at the bottom of it, next the fender.

D, ſhews this box half taken out, with a cover E, (in the plate repreſented as turned back,) moving at each end upon ſquares, or what clock-makers call cocks, with centre pivots; by which means, when it is ſhut to cover the box, a vacancy, for the paſſage of the cinders into the box, is left; and the cover, by moving on ſuch centre pivots when the box is taken out, ſhuts back, as in the plate, cloſe upon the front of the grating or net-work, to prevent, while the box is moved, the falling of cinders into its place. The box may be made with one end of it to fall, in order that it may be more eaſily diſcharged of the cinders. In witneſs whereof, &c.

XVI.

Fig. 1.

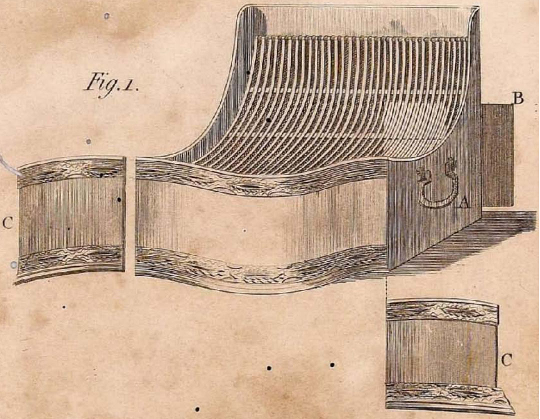
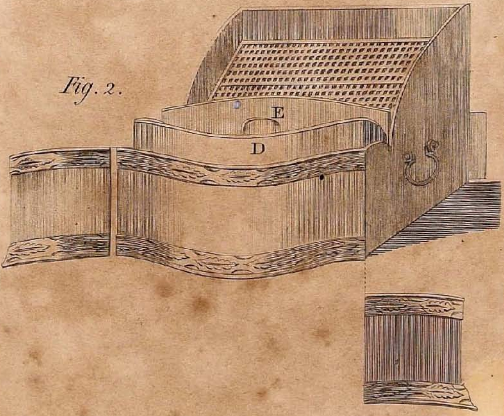


Fig. 2.



XVI. *Experiment upon the Resistance of the Air.* *By* Richard Lovell Edgeworth, *Esquire, F. R. S.*

From the Philosophical Transactions of the Royal Society of London.

Many experiments have been tried to ascertain the force and velocity of the wind, with a view to the construction and management of different engines, and more particularly for the purposes of navigation. Several machines, which have been employed in these enquiries, are described in the Transactions of the Royal Society, and in the Memoirs of Foreign Academies; but the most accurate which I have seen was invented by the late Sir Charles Knowles; and, from a number of experiments made with it, he had constructed tables, shewing at one view the force of the wind upon each sail of a ship, at every degree of velocity from one to ninety miles an hour.

But theſe calculations, and many more of a ſimilar nature, that are to be met with in Belidor's *Architecture Hydraulique*, and other books, are founded upon a ſuppoſition that the effect of the wind is directly as the ſurface upon which it acts. If, for inſtance, its force be eſtimated as one upon one ſquare yard, its force upon two ſquare yards ſhould be eſtimated as two, upon three ſquare yards as three, &c. but in fact this proportion is not to be depended upon; nor muſt the reſiſtance of ſurfaces be eſtimated merely by their extent, but ſeveral other circumſtances muſt be taken into conſideration.

No figures can reſemble each other more than a parallelogram and a ſquare that have the ſame ſuperficial contents, as they are both bounded by four ſtraight lines meeting at right angles, yet they oppoſe different degrees of reſiſtance to the air.

If two ſimilar cards, for inſtance, are placed oppoſite the wind, one upon its end and the other on its ſide, and both inclined to the ſame angle, the wind will have the greater effect upon the card that is placed end-ways.

To determine the difference of reſiſtance between theſe two ſurfaces, and to aſcertain the effect of other figures moving through the air, I tried the following experiments. The two firſt

are

are to be found in Mr. Robins's Treatiſe upon Gunnery; but I thought it proper to repeat them, that they might be more readily compared with others made with the ſame apparatus; eſpecially as Mr. Robins made uſe of a machine conſtructed upon a ſmaller ſcale than mine, and turning upon friction-wheels, which are not proper for machines of this nature, nor indeed for any purpoſe, where an uniform motion is required.

Having faſtened a ſtrong joiſt of wood from one ſide of a large room to the other, ſo as to form a kind of bridge at ſome diſtance from the floor, I erected a perpendicular ſhaft or roller, which turned freely in braſs ſockets fixed into the floor and bridge, upon pivots of hardened ſteel, one-ſixteenth of an inch in diameter. On each ſide of this roller was extended an arm of deal, feather-edged, and ſupported by ſtays of the ſame material, feathered in the ſame manner, to oppoſe as little ſurface as poſſible to the air, when in motion.

Round the upper part of this roller was wound a ſtring of cat-gut, which, paſſing over pullies, properly diſpoſed, was faſtened to a ſcale that deſcended into the well of an adjoining ſtair-caſe.

The extremity of theſe arms deſcribed a ſpace of more than forty feet in every revolution; the

 weight

weight defcending, in the fame time, only fix inches. The time in all the following experiments was the fame; and, as each revolution was performed in four feconds, the velocity of the end of the arm on which the furface was fixed, was at the rate of about feven miles an hour.

The firft figure that I tried was a parallelogram of tin, nine inches long, and four inches wide. Its longeft fides were placed parallel to the floor, at the extremity of one of the arms. It's fhorteft fides were inclined to an angle of forty-five degrees from the perpendicular, and in this fituation it was carried round, with its furface againft the air.

After fuffering it to revolve until I was fatisfied that its motion was become uniform, I put as much weight into the fcale as moved it with a velocity of five turns in twenty feconds. I then changed the fituation of the parallelogram, placing its fhorteft fides parallel to the floor, and inclined to the fame angle as before. I now found, that more weight was required to produce the fame velocity, though the quantity of furface was the fame as in the preceding experiment. The weight neceffary to put the machine alone in motion, with the velocity above mentioned, was two pounds and a half. When it carried the parallelogram with one of its fhorteft fides downwards, it required four pounds and a half additional

tional weight; and, when the parallelogram was reversed, another half pound was barely sufficient to give it the same velocity.

The difference, therefore, occasioned by placing the same parallelogram with its longer or shorter sides inclined from the direction of its motion, was equal to one-tenth of the greatest resistance.

It has been observed, that in these two experiments the mean velocity of the plane was not the same; as its extremity extended farther from the centre of the machine in one than in the other. This is strictly true; but the size of the parallelogram bore so small a proportion to the length of the radius to which it was fastened, that the error arising from this circumstance is scarcely perceptible, and the advantage being in favour of that which required the least weight, I did not think it necessary to bring it into account.

Having formed a general idea of the reason of the difference in these experiments, it occurred to me, that there would be a greater disproportion between the resistance of some other figures, which Mr. Robins had not tried; and having put a rhomboid, in the form of a lozenge, nine inches long, and four broad, in the place of the parallelogram, the difference was increased from one-tenth to one-seventh of the weight employed to give them the required velocity.

Purſuing the ſame reaſoning that led to the laſt experiment, it occurred to me, that even againſt figures of exactly the ſame ſhape, the reſiſtance of the air, when the dimenſions of the figures were enlarged, would not be increaſed in the ſame proportion as the ſize of the planes, but in a much higher ratio; and that, by bending the planes as a ſail, the reſiſtance would be ſtill farther increaſed, though the ſection of air that would be intercepted by the planes, muſt by theſe means be conſiderably leſſened.

The reſult far ſurpaſſed my expectations. A ſquare of tin, containing ſixteen ſquare inches, placed perpendicularly, was reſiſted as two and a half. A ſquare containing ſixty-four inches, or four times the former quantity, inſtead of meeting with a reſiſtance as ten, or four times the former reſiſtance, required no leſs than fourteen pounds to give it the ſame velocity.

Four-tenths (or nearly half as much again) was an increaſe of reſiſtance that made me ſuſpect ſome error in the experiment; but, having repeated it ſeveral times with great care, and having examined all the parts of the machine, I was ſatisfied that I had made no miſtake.

I now placed the parallelogram of nine inches long upon the arms of the machine, with its ſhorteſt ſides parallel to the horizon, bending it to ſuch an arch that its chord meaſured eight inches,

inches, and inclining it to an angle of forty-five degrees; and, though the section of air that it intercepted was by these means diminished one-ninth, yet the resistance was increased from five to five and a half; and, when the parallelogram was bent yet farther, and its chord contracted almost to seven inches, the resistance was increased to five and three-quarters.

I mention these numbers in gross, to avoid confusion; but, in the table at the end of this paper, the measures and weights are set down exactly.

Dr. Hook, whose name must be respected by every experimental philosopher, was aware, that although he thought he could demonstrate that flat sails were preferable to such as were curved and hollowed by the wind, yet, until proper experiments had been tried, nothing could be positively determined.

He says, somewhere in his posthumous works, "That he was surprised at the obstinacy of sea-
"men, in continuing, after what appeared the
"clearest demonstration to the contrary, to pre-
"fer bellying or bunting sails to such as were
"hauled taught; but that he would, at some
"future time, add the test of experiment to ma-
"thematical investigation." He reasoned upon a supposition, that the air in motion followed the same

ſame laws as light; and that it was reflected from ſurfaces with the angle of reflection equal to the angle of incidence; which is not the caſe, as it never makes an angle with the plane, but is always reflected in curves. Monſieur Parent, and other mathematicians, have fallen into the ſame miſtake. No demonſtration of this ſort was more commonly known or received among practical mechanics, than that the beſt angle for the ſails of a windmill, at the beginning of their motion, was an angle of forty-five degrees; and that the maximum of an under-ſhot water-wheel was, when it moved with one-third of the velocity of the water: but Mr. Smeaton, in an excellent paper in the Philoſophical Tranſactions, has refuted this opinion by the cleareſt experiments.

I had intended to diverſify theſe experiments, and to extend them to a more intereſting ſubject of enquiry, *viz.* to determine the beſt ſhape of ſails, and the angle to which they ſhould be ſet, to obtain the greateſt progreſſive effect, with the leaſt lee-way; but, as a more complicated apparatus than I could at preſent procure is neceſſary for this purpoſe, I determined to offer the ſlight progreſs I have made, in hopes that ſome gentleman, more converſant and more intereſted than myſelf in theſe enquiries, may purſue them with ſucceſs and advantage to the public. I ſhall only remark,

remark, that the general cause of the different resistance of the air upon surfaces of different shapes, is the stagnation of that fluid near the middle of the plane upon which it strikes. The shape and size of the portion thus stagnated, differs from the shape and angle of the plane. The elasticity of the air permits the parts in motion to compress those which are first stopped or retarded by the plane, and forms, as it were, a new surface, of a different shape; for the reception of those particles which succeed. With the assistance of a good solar microscope, the curves of the air striking against different surfaces may be delineated; and when the general facts are once clearly ascertained, mathematicians will have an ample field for curious and useful speculation.

TABLE.

	Turns.	Time.	Weight.
Machine alone — — —	5	4	2 8
With a parallelogram of nine inches long and four broad, one of its longeſt ſides parallel to the horizon, and the parallelogram inclined to an angle of 45°, —	5	4	7 0
Ditto, with one of its ſhorteſt ſides downwards, —	5	4	7 9
With a lozenge nine inches long and four broad, with its longeſt ſide parallel to the horizon, — —	5	4	5 8
Ditto reverſed, — — —	5	4	6 0
With a ſquare piece of tin, four inches by four inches,	5	4	5 0
Ditto, eight inches by eight inches, — —	5	4	16 6
With the former parallelogram, placed with one of its ſhorteſt ſides downwards, inclined to an angle of 45°, and bent into an arch whoſe chord was eight inches long, — — — —	5	4	8 0
Ditto bent to arch, the chord of which was ſeven inches and a quarter, — — —	5	4	8 5

XVII. *Obſervations on Iron and Steel.* By Mr. Joseph Collier.

From the Memoirs of the Literary and Philosophical Society of Manchester.

After examining the works of different authors who have written on the ſubject of making iron and ſteel, I am perſuaded that the accounts given by them, of the neceſſary proceſſes and operations, are extremely imperfect. Chemiſts have examined and deſcribed the various compound minerals containing iron, with great accuracy, but have been leſs attentive to their reduction. This obſervation more particularly applies to ſteel, of the making of which, I have not ſeen any correct account.

It is ſingular to obſerve, how very imperfectly the cementation of iron has been deſcribed, by men of great eminence in the ſcience of chemiſtry. M. Fourcroy ſtates the length of time neceſſary for the cementation of iron to be about twelve hours; but it is difficult to diſcover whether he alludes to caſt or to bar ſteel: for

he ſays, that ſhort bars of iron are to be put into an earthen box, with a cement, and cloſed up. Now ſteel is made from bars of iron of the uſual length and thickneſs; but caſt ſteel is made according to the proceſs deſcribed by M. Fourcroy, with this eſſential difference, the operation is begun upon bar ſteel, not bar iron.

Mr. Nicholſon is equally unfortunate in the account given in his Chemical Dictionary. He ſays, that the uſual time required for the cementation of iron is from ſix to ten hours, and cautions us againſt continuing the cementation too long; whereas the operation, from the beginning to the end, requires ſixteen days at leaſt. In other parts of the operation he is equally defective, confounding the making of bar with that of caſt ſteel, and not fully deſcribing either. In ſpeaking of the uſes of ſteel, or rather of what conſtitutes its ſuperiority, Mr. Nicholſon is alſo deficient. He obſerves, that "its moſt uſeful "and advantageous property is that of becom- "ing extremely hard when plunged into water." He has here forgotten every thing reſpecting the temper and tempering of ſteel inſtruments, of which however he takes ſome notice in the ſame page. "Plunging into water" requires a little explanation: for, if very hot ſteel be immerſed in cold water, without great caution, it will crack, nay, ſometimes break to pieces. It is however neceſſary

neceſſary to be done, in order to prevent the ſteel from growing ſoft, and returning to the ſtate of malleable iron; for, were it permitted to cool in the open air, the carbon which it holds in combination would be diſſipated*.

I ſhall, at preſent, confine my remarks to the operations performed on iron, in Sheffield and its neighbourhood: whence various communications have been tranſmitted to me by reſident friends, and where I have myſelf ſeen the operations repeatedly performed.

The iron made in that part of Yorkſhire is procured from ores found in the neighbourhood, which are of the argillaceous kind, but intermixed with a large proportion of foreign matter. Theſe, however, are frequently combined with richer ores, from Cumberland and other places. The ore is firſt roaſted with cinders, for three days, in the open air, in order to expel the ſulphureous or arſenical parts, and afterwards taken to the furnaces; ſome of which are conſtructed ſo that their internal cavity has the form of two four-ſided pyramids joined baſe to baſe; but thoſe moſt commonly uſed are of a conical form, from forty to fifty feet high. The furnace is charged

* It is the opinion of ſome metallurgiſts, that a partial abſtraction of oxygen takes place, by plunging hot metal into cold water.

at the top with equal parts of coal-cinder and lime-ſtone. The lime-ſtone acts as a flux, at the ſame time that it ſupplies a ſufficient quantity of earthy matter to be converted into ſcoriæ, which are neceſſary to defend the reduced metal from calcination, when it comes near the lower part of the furnace. The fire is lighted at the bottom; and the heat is excited by means of two pair of large bellows, blowing alternately. The quantity of air generally thrown into the furnace, is from a thouſand to twelve hundred ſquare feet in a minute. The air paſſes through a pipe, the diameter of which is from two inches and a quarter to two and three quarters wide. The compreſſion of air which is neceſſary, is equal to a column of water four feet and a half high. The ore melts as it paſſes through the fire, and is collected at the bottom, where it is maintained in a liquid ſtate. The ſlagg, which falls down with the fuſed metal, is let off, by means of an opening in the ſide of the furnace, at the diſcretion of the workmen.

When a ſufficient quantity of regulus, or imperfectly reduced metal, is accumulated at the bottom of the furnace, (which uſually happens every eight hours,) it is let off into moulds, to form it for the purpoſes intended, ſuch as, cannon, or pig iron.

Crude iron is diftinguifhed into white, black, and grey. The white is the leaft reduced, and more brittle than the other two. The black is that with which a large quantity of fuel has been ufed; and the grey is that, which has been reduced with a fufficient quantity of fuel, of which it contains a part in folution.

The operation of refining crude iron confifts in burning the combuftible matter which it holds in folution; at the fame time that the remaining iron is more perfectly reduced, and acquires a fibrous texture. For this purpofe, the pigs of caft iron are taken to the forge, where they are firft put into what is called the refinery, which is an open charcoal-fire, urged by a pair of bellows, worked by water or a fteam-engine; but the compreffion of air, in the refinery, ought to be lefs than that in the blaft furnace. After the metal is melted, it is let out of the fire by the workmen, to difcharge the fcoriæ; and then returned, and fubjected to the blaft as before. This operation is fometimes repeated two or three times, before any appearance of malleability (or what the workmen call coming into nature) takes place; this they know by the metal's firft affuming a granular appearance, the particles appearing to repel each other, or at leaft to have no figns of attraction. Soon afterwards they begin to adhere; the attraction increafes very rapidly, and it is

is with great difficulty that the whole is prevented from running into one maſs; which it is deſirable to avoid, it being more convenient to ſtamp ſmall pieces into thin cakes: this is done by putting the iron immediately under the forge-hammer, and beating it into pieces about an inch thick, which eaſily break from the reſt during the operation. Theſe ſmall pieces are then collected, and piled upon circular ſtones, which are an inch thick, nine inches in diameter, and about ten inches high. They are afterwards put into a furnace, in which the fire is reverberated upon them, until they are in a ſemi-fluid ſtate. The workmen then take one out of the furnace, and draw it into a bar under the hammer; which being finiſhed, they apply the bar to another of the piles of ſemi-fluid metal, to which it quickly cements, is taken again to the hammer, (the bar firſt drawn ſerving as a handle,) and drawn down as before. The imperfections in the bars are remedied by putting them into another fire called the chafery, and again ſubjecting them to the action of the forge-hammer.

The above method is now moſt in uſe, and is called flouriſhing; but the iron made by this proceſs is in no reſpect ſuperior to that which I am going to deſcribe. It is, however, not ſo expenſive, and requires leſs labour.

The

The procefs for refining crude iron which was moft common previoufly to the introduction of flourifhing, is as follows.

The pigs of caft iron are put into the refinery, as above, where they remain until they have acquired a confiftence refembling pafte, which happens in about two hours and a half. The iron is then taken out of the refinery, laid upon a caft iron plate on the floor, and beaten by the workmen with hand-hammers, to knock off the cinders and other extraneous matters which adhere to the metal. It is afterwards taken to the forge-hammer, and beaten, firft gently, till it has obtained a little tenacity; then the middle part of the piece is drawn into a bar, about half an inch thick, three inches broad, and four feet long; leaving at each end a thick fquare lump of imperfect iron. In this form it is called ancony. It is now taken to the fire called the chafery, made of common coal; after which, the two ends are drawn out into the form of the middle, and the operation is finifhed.

There is alfo a third method of rendering crude iron malleable, which, I think, promifes to be abundantly more advantageous than either of the two former, as it will difpenfe both with the refinery and chafery, and nothing more will be neceffary than a reverberating furnace, and a furnace to give the metal a malleable heat, about the

the middle of the operation. The large forge-hammer will alſo fall into diſrepute; but in its place muſt be ſubſtituted metal rollers, of different capacities, which, like the forge-hammer, muſt be worked either by a water-wheel or a ſteam-engine.

It is by the operation of the forge-hammer or metal rollers, that the iron is deprived of the remaining portion of impurity, and acquires a fibrous texture.

The iron made by the three foregoing proceſſes is equally valuable, for by any of them the metal is rendered pure; but, after thoſe different operations are finiſhed, it is the opinion of many of the moſt judicious workers in iron, that laying it in a damp place, for ſome time, improves its quality; and to this alone ſome attribute the ſuperiority of foreign iron, more time elapſing between making and uſing the metal. To the latter part of this opinion I can by no means accede; as it is well known that the Swediſh * ores contain much leſs heterogeneous matter than ours, and are generally much richer, as they uſually yield about ſeventy *per quintal* of pure iron; whereas the average of ours is not more than thirty or forty †: add to this, that

* Steel is commonly made of Swediſh iron.

† The iron made from the ore found in the neighbourhood of Sheffield, contains a great deal of phoſphate of iron or ſiderite, which renders the metal brittle when cold.

 the

the Swedifh ores are fmelted in wood fires, which gives the iron an additional fuperiority.

Iron inftruments are cafe-hardened by heating them in a cinder or charcoal fire; but, if the firft be ufed, a quantity of old leather, or bones, muft be burnt in fire, to fupply the metal with carbon. The fire muft be urged, by a pair of bellows, to a fufficient degree of heat; and the whole operation is ufually completed in an hour.

The procefs for cafe-hardening iron is in fact the fame as for converting iron into fteel, but not continued fo long, as the furface only of the article is to be impregnated with carbon.

Some attempts have been made to give caft iron, by cafe-hardening, the texture and ductility of fteel, but they have not been very fuccefsful. Table-knife and pen-knife blades have been made of it, and, when ground, have had a pretty good appearance; but the edges are not firm, and they foon lofe their polifh. Common table-knifes are frequently made of this metal.

The cementation of iron converts it into fteel: a fubftance intermediate between crude and malleable iron.

The furnaces for making fteel are conical buildings; about the middle of which are two troughs of brick or fire-ftone, which will hold about four tons of iron in the bar. At the bottom is a long grate, for fire. The fteel furnace, however, is

not well adapted for defcription. I fhall therefore avail myfelf of an accurate drawing, which was communicated to me by a gentleman converfant with the manufacture, and which is copied in Plate VIII.

A layer of charcoal-duft is put upon the bottom of the trough; upon that, a layer of bar iron, and fo on alternately, until the trough is full. It is then covered over with clay, to keep out the air; which, if admitted, would effectually prevent the cementation. When the fire is put into the grate, the heat paffes round by means of flues, made at intervals, by the fides of the trough. The fire is continued until the converfion is complete, which generally happens in about eight or ten days. There is a hole in the fide, by which the workmen draw out a bar occafionally, to fee how far the tranfmutation has proceeded: this they determine by the blifters upon the furface of the bars. If they be not fufficiently changed, the hole is again clofed carefully, to exclude the air; but if, on the contrary, the change be complete, the fire is extinguifhed, and the fteel is left to cool for about eight days more, when the procefs for making bliftered fteel is finifhed.

For fmall wares, the bars are drawn under the tilt-hammer, to about half an inch broad, and three fixteenths of an inch thick.

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The change wrought on bliſtered ſteel by the tilt-hammer, is nearly ſimilar to that effected on iron from the refinery by the forge-hammer. It is made of a more firm texture, and drawn into convenient forms for uſe.

German ſteel is made by breaking the bars of bliſtered ſteel into ſmall pieces, and then putting a number of them into a furnace; after which, they are welded together, and drawn to about eighteen inches long; then doubled, and welded again; and finally drawn to the ſize and ſhape required for uſe. This is alſo called ſhear ſteel, and is ſuperior in quality to the common tilted ſteel.

Caſt ſteel is alſo made from the common bliſtered ſteel. The bars are broken and put into large crucibles, with a flux. The crucible is then cloſed up with a lid of the ſame ware, and placed in a wind-furnace. By the introduction of a greater or ſmaller quantity of flux, the metal is made harder or ſofter. When the fuſion is complete, the metal is caſt into ingots, and then called ingot-ſteel; and that which afterwards undergoes the operation of tilting, is called tilted caſt ſteel.

The caſt ſteel is the moſt valuable, as its texture is the moſt compact, and it admits of the fineſt poliſh.

Sir T. Frankland has communicated a procefs, in the Tranfactions of the Royal Society *, for welding caft fteel and malleable iron together; which, he fays, is done, by giving the iron a malleable, and the fteel a white heat; but, from the experiments which have been made at my requeft, it appears, that it is only foft caft fteel, little better than common fteel, that will weld to iron: pure fteel will not; for, at the heat defcribed by Sir T. Frankland, the beft caft fteel either melts, or will not bear the hammer.

It may here be obferved, as was mentioned before, that fteel is an intermediate ftate between crude and malleable iron, except in the circumftance of its reduction being complete; for, according to the experiments of Reaumur and Bergman, fteel contains more hydrogen gas than caft iron, but lefs than malleable iron; lefs plumbago than the firft, but more than the latter; an equal portion of manganefe with each; lefs filiceous earth than either; more iron than the firft, but lefs than the fecond. Its fufibility is likewife intermediate, between the bar iron and the crude. When fteel has been gradually cooled from a ftate of ignition, it is malleable and foft, like bar iron; but, when ignited and plunged into

* Philofophical Tranfactions for 1795.

cold

cold water, it has the hardneſs and brittleneſs of crude iron.

From the foregoing facts, we are juſtified in drawing the ſame concluſions with Reaumur and Bergman, (but which have been more perfectly explained by Vandermonde, Berthollet, and Monge,) that crude iron is a regulus, the reduction of which is not complete, and which conſequently will differ, according as it approaches more or leſs to the metallic ſtate. Forged iron, when previouſly well refined, is the pureſt metal, for it is then the moſt malleable and the moſt ductile; its power of welding is the greateſt, and it acquires the magnetic quality ſooneſt. Steel conſiſts of iron perfectly reduced, and combined with charcoal; and the various differences in bliſtered ſteel, made of the ſame metal, conſiſt in the greater or leſs proportion of charcoal imbibed.

Iron gains, by being converted into ſteel, about the hundred and eightieth part of its weight.

In order to harden ſteel, it muſt be put into a clean charcoal, coal, or cinder fire, blown to a ſufficient degree of heat by bellows. The workmen ſay, that neither iron nor ſteel will harden properly without a blaſt. When the fire is ſufficiently hot, the inſtrument intended to be hardened muſt be put in, and a gradual blaſt from the

the bellows continued until the metal has acquired a regular red heat; it is then to be carefully quenched in cold water. If the ſteel be too hot when immerſed in water, the grain will be of a rough and coarſe texture; but if of a proper degree of heat, it will be perfectly fine. Saws and ſome other articles are quenched in oil.

Steel is tempered by again ſubjecting it to the action of the fire. The inſtrument to be tempered we will ſuppoſe to be a razor made of caſt ſteel. Firſt, rub it upon a grit ſtone until it is bright; then put the back upon the fire, and in a ſhort time the edge will become of a light ſtraw colour, whilſt the back is blue. The ſtraw colour denotes a proper temper, either for a razor, graver, or pen-knife. Spring knifes require a dark brown: ſciſſars, a light brown, or ſtraw colour: forks or table knifes, a blue. The blue colour marks the proper temper for ſwords, watch-ſprings, or any thing requiring elaſticity. The ſprings for pen-knifes are covered over with oil, before they are expoſed to the fire to temper.

EXPLANATION OF THE FIGURES.

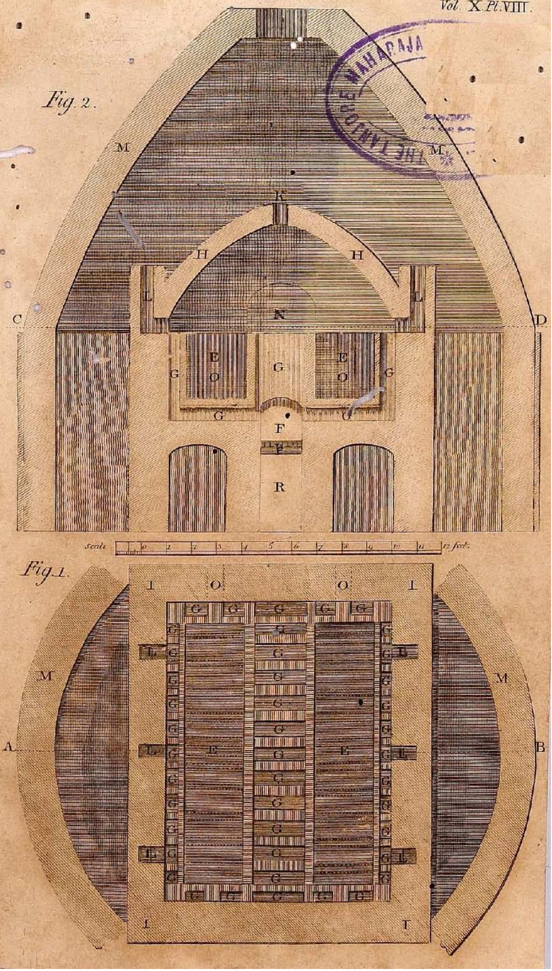
(See Plate VIII.)

Fig. 1. is a plan of the furnace. Fig. 2. is a ſection of it, taken at the line AB. The plan is taken at the line CD. The ſame parts of the furnace are marked with the ſame letters in the plan and in the ſection. E, E, are the pots or troughs, into which the bars of iron are laid to be converted. F, is the fire-place. P, the fire bars. R, the aſh-pit. G, G, &c. are the flues. HH, is an arch, the inſide of the bottom of which correſponds with the line IIII, Fig. 1, and the top of it is made in the form of a dome, having a hole in the centre at K, Fig. 2. L, L, &c. are ſix chimneys. M M, is a dome, ſimilar to that of a glaſs-houſe, covering the whole. At N there is an arched opening, at which the materials are taken in and out of the furnace, and which is cloſely built up when the furnace is charged. At O O there are holes in each pot, through which the ends of three or four of the bars are made to project quite out of the furnace. Theſe are for the purpoſe of being drawn out occaſionally, to ſee if the iron be ſufficiently converted.

The

The pots are made of fire-tiles, or fire ſtone; the bottoms of them are made of two courſes; each courſe being about the thickneſs of the ſingle courſe which forms the outſides of the pots. The inſides of the pots are of one courſe, about double the thickneſs of the outſide. The partitions of the flues are made of fire-brick, and are of different thickneſſes, as repreſented in the plan, and by dotted lines in the bottom of the pots: theſe are for ſupporting the ſides and bottoms of the pots, and for directing the flame equally round them. The great object is, to communicate to the whole an equal degree of heat in every part. The fuel is put in at each end of the fire-place; and the fire is made the whole length of the pots, and kept up as equally as poſſible.

THE TANJORE MAHARAJA



XVIII. *Conclusion of Mr.* Sheldrake's *Dissertation on painting in Oil, in a Manner similar to that practised in the antient Venetian School.*

(From Page 62.)

THE artist will remark that, in describing the whole of the Venetian method of painting, I have said nothing of the manner of producing those demi-tints which conduce so much to the brilliancy of a picture, which are so difficult to execute, and in which he most frequently fails. Those tints are, in the ordinary modes of painting, produced by the mixture of black, grey, blue, or brown, (according to the judgement of the artist,) with the local colours of the objects. It is these tints which, from their being made with such colours, it is difficult to get clear, and which never are so clear in any other as in the Venetian pictures, and in some of the Flemish ones painted upon analogous principles. The fact is, that those painters produced all such tints without the admixture of any colour to re-

present them, and by a method ſo like that by which they are produced in nature, that this circumſtance alone enſures a degree of brightneſs to their colours, and of harmony to their ſhadows, that it is perhaps impoſſible to produce, in an equal degree, by any other mode of painting.

It is a ſingular fact, which I have not ſkill in phyſics to be able to account for, though, by numerous experiments, I have aſcertained it beyond contradiction, that if upon any degree of brown, between the deepeſt and the lighteſt brown-yellow, we paint pure white, in gradations, from the ſolid body to the lighteſt tint that can be laid on, all the tints between the ſolid white and the ground will appear to be *grey*, intenſe in proportion to the depth of the ground, and the thinneſs of the white laid upon it. But, in every caſe, all the tints laid upon one ground will harmonize with each other, and form one connected chain, (if I may uſe the expreſſion,) which will perfectly unite the higheſt light with the darkeſt ſhade.

If then we examine the component ſubſtances of a Venetian picture, we ſhall find the lighter parts conſiſt only of white, to repreſent the light; and, of the local colours of the objects it repreſents, the demi-tints are imitated by an *appearance* almoſt as deceptive as the ſimilar appearances in nature: but, in every other method of painting, theſe demi-tints are produced by mix-

ing

ing fome dufky colour with the local colours and the light. The comparifon of thefe methods will afford a demonftrative reafon, why the Venetian muft be brighter than any other mode of painting.

Having fhewn, as near to a demonftration as the nature of the fubject will perhaps admit, why thofe parts of a Venetian picture that are connected with light and colours are brighter than the correfponding parts of any other pictures, it remains to explain the caufe of fimilar fuperiority in the darker parts of the fame pictures.

It has been faid, with much confidence, that as white reprefents light, fo black is the reprefentative of darknefs. But, though this may be true in phyfics, it certainly is not fo in painting; for the painter's art is to reprefent objects as they *appear*, in point of colour, to be, not as they really are. Thus, if I know an object is perfectly black, and am to reprefent it as it appears to be at the diftance of fifty feet, black from the pallet will not produce a good imitation of it, becaufe the interpofition of fifty feet of the atmofphere will caufe it to appear of a colour different from what it really is; and, *vice verfâ*, if we go into a cavern, a cellar, or a room, fo darkened that the colour of no object can be diftinctly feen, and if we there hold any folid black fubftance near to the eye, the difference will be vifible at once; the black object will be imme-

diately diſtinguiſhed, by its ſolidity and colour, from the ſurrounding ſpace, and from ſuch remote objects as may be obſcurely viſible through it. Theſe objects actually poſſeſs their individual colours, and only appear indiſtinctly, from the abſence of light. The black object may appear ſolid, and of that colour, from its proximity to the eye; but the circumjacent ones will appear of a colour perfectly diſtinct from it, more or leſs tranſparent, in proportion to their diſtance from the eye, and ſhewing a portion of their individual colours, according to the quantity of ill-defined light that may be admitted. Thus we ſee (if I may venture to mention ſo notorious a truiſm) that ſhadows are nothing real: they only ſeem to exiſt in the abſence of light, and give to objects an ill-defined appearance, diſtinct from, though in ſome inſtances mixed with, light and colours in different degrees; but, as the painter muſt repreſent this *appearance* by ſomething *real*, he chooſes the colours moſt analogous, *viz.* browns, and the moſt tranſparent of their claſs, to repreſent this tranſparent, but imperfectly defined, appearance in nature.

It has been ſuppoſed that the Venetian painters had ſome peculiarly rich and tranſparent brown colour, which is ſeen to pervade all the works of that ſchool, the effect of which no modern artiſt has

has been able to imitate, and which therefore is ſuppoſed to have been loſt. It is not very probable, that a colour ſo common as to pervade the works of the worſt as well as of the beſt artiſts of that ſchool, ſhould be ſo unaccountably loſt; and, as the effect attributed to it may be eaſily produced by the mode of painting I have deſcribed, it is not unreaſonable to conclude, that this much-lamented colour has never exiſted.

It is well known that chalk, and other earths of the ſame kind, loſe, when wetted, much of their whiteneſs, and become ſemi-tranſparent: it is equally certain, that if umber, or other earths, are mixed with chalk, and ſaturated with varniſh, after they are laid on the cloth, they in like manner become diaphanous, and are infinitely more brilliant than the ſame colours can be when mixed with white lead and oil. This ſeems, on good grounds, to have been the baſis of the Venetian method of painting, and all its peculiar effects; at leaſt, if I may draw any concluſion from the numerous experiments I have made. But, if artiſts whoſe talents will enable them to repeat thoſe experiments to the beſt advantage, ſhould be induced to do ſo, the fact will be determined in the moſt ſatisfactory manner.

I may now be permitted to ſay, it is difficult, if not impoſſible, to conceive a theory more ſimple,

ple, more beautiful, or more true, than that of Sir Joſhua Reynolds. It is certainly impoſſible to form a practice more ſimple, or more conformable to that theory, than the one I have deſcribed, as will be evident on recapitulating the particulars.

The artiſt, having determined what hue ſhould pervade his picture, formed his ground with that colour, prepared in diſtemper: upon this the ſubject was drawn, and the darker ſhades painted in with tranſparent colours, which ſunk into the ground: with pure white he then painted in all the lights and demi-tints, and, laſtly, glazed in the colours, each in its place. Upon applying the varniſh, the darker ſhades were, as to body, incorporated with the ground; and thus, though different in colour, appeared thinner, and more tranſparent, than any colours could be when laid upon any ground: the full effect of every colour was brought out, and the picture was complete.

Whoever has been accuſtomed to paint, or to mark the progreſs of painting, in the common way, and will reflect on the practice of the method I have deſcribed, by artiſts who had been brought up to it, muſt ſee that ſuch artiſts would paint with a degree of facility, expedition, and certainty, as to effect, that could never be equalled

in

in the ordinary way of painting in oil; befides, it will be evident, that an artift would not only paint a picture himfelf with more facility, but, if he had occafion, could employ a number of fubordinate artifts upon large works, and put thofe works out of hand with more uniformity, as to merit and effect, than if he were to employ fuch affiftants in fimilar works, to be painted in the common way.

I am fenfible how little attention will, and perhaps ought to be paid to obfervations on painting, when made by thofe who are not profeffionally artifts; for practical men acquire a kind of knowledge that can never be obtained in any other way; but, at the fame time, they contract prejudices that often prevent them from fully inveftigating any novelty in practice that may be offered to their notice. The fpeculative man, on the contrary, who inveftigates the properties of matter, unfhackled by practical prejudices, and with ideas purely chemical or philofophical, will be more likely to afcertain all the facts relative to any theory that may become the object of enquiry. In this way I hope I have proceeded, in this inveftigation. I have endeavoured to confider pictures as maffes of matter, poffeffing its properties, but differing from each other in degree of brilliancy, tranfparency, and duration.

I have

I have endeavoured to aſcertain the cauſes of this difference; with what ſucceſs, the Society will determine; and with what utility, muſt be hereafter aſcertained, by the practice of thoſe for whoſe uſe the inveſtigation was intended.

I ought, perhaps, here to take leave of the ſubject; but, as I have been induced to ſubmit to the Society's notice an attempt at painting, it may be expected that I ſhould give an account of the manner in which the pictures I have ſent were painted.

I have already mentioned, that there are ſome difficulties in the method of painting I have deſcribed as being that of the old artiſts, and which would form objections of conſiderable force to the practice of it by artiſts who are well acquainted with the uſual modes of painting: theſe difficulties are, firſt, the ground abſorbs the oil from the colours ſo faſt, that they are not ſo manageable as in common oil-painting; ſecondly, the effect of the picture is not ſeen till the finiſhing varniſh is laid on; and, thirdly, as the effect is not ſeen till the picture is finiſhed, it will ſometimes diſappoint the artiſt, and in that caſe it will be difficult, if at all practicable, to alter it.

I believe the proceſs I have deſcribed in the beginning of this paper is ſimilar to that of Miſs

Provis;

Provis; but the artiſts who are acquainted with her recipe can aſcertain whether my conjectures on this ſubject are right or not. I am certain at leaſt, that theſe difficulties occurred in my attempts to paint, and to obviate them I adopted the following proceſs.

I prepared the ground in diſtemper, and painted the dark parts in the way I have deſcribed: I then varniſhed the ground with copal oil-varniſh, till it was fully ſaturated, and by this means the full effect of that part of the picture was ſeen: upon this I painted the lighter parts with white, uſing much of the vehicle where the colour was thin, and little in the ſolid parts, leaving the white in them dead: by this means, I underſtood the effect of my chiaro-oſcuro, as I ſaw the effect of the demi-tints nearly as well as when the picture was finiſhed.

Upon this I glazed the colours, in the way I have deſcribed in the beginning of this paper, and finiſhed the picture. I often found (probably from want of practice) that the effect was different from what I intended, as the effect of the colours, added to that of the chiaro-oſcuro, produced an eſſential alteration in the whole; as I took care, in general, that the defect did not ariſe from too much white, I added more where it was deficient, and glazed freſh colours over it, which

 united

united perfectly with what had been done before, and did not give the appearance of a mended picture. If the defect was from too much white, I glazed on it a colour ſimilar to that of the ground, painted with freſh white upon that, and glazed the proper colours over it. In this way, I found I could alter the picture, but not ſo well as in the former caſe.

I found I could, when neceſſary, increaſe the effect of the picture, by painting on the principal maſs or maſſes of light with the local colours, only mixed with white; as this practice brought thoſe parts more forward, by making them appear ſolid, and thus contraſting them with the tranſparency of the reſt of the picture. In this way, I found I could uſe the colours tempered with copal varniſh, without difficulty; and I believe, that if I had been accuſtomed to paint large pictures, I could have painted one as large as life, as eaſily as either of thoſe I have ſubmitted to the Society's inſpection.

XIX. *Method of preserving young Plantations of Trees from being injured by Hares or Rabbits.* By WILLIAM PATTENSON, *Esquire, of Ibornden, Kent.*

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

HARES, rabbits, and rats, have a natural antipathy to tar; but tar, though fluid, contracts (when expofed to the fun and air for fome time) a great drynefs, and a very binding quality; and, if applied to trees in its natural ftate, will occafion them to be bark-bound. To remove this difficulty, tar is of fo ftrong a favour, that a fmall quantity, mixed with other things, in their nature loofe and open, will give the whole mixture fuch a degree of its own tafte and fmell, as will prevent hares, &c. from touching what it is applied to.

Take any quantity of tar, and fix or feven times as much greafe, ftirring and mixing them

 well

well together; with this composition brush th stems of young trees, as high as hares, &c. can reach, and it will effectually prevent their being barked. I believe, if a plantation of ash (which they are very fond of) were made in a rabbit-warren, this mixture would certainly preserve it. These animals do great mischief amongst flowering shrubs, and are particularly fond of Spanish broom, Scorpion-senna, and ever-green Cytisus. I have had those shrubs eaten down to a stump; but, as the mixture cannot be conveniently applied to them, I have enclosed their branches with new tar twine, putting it several times round the shrub, which has had the desired effect. Tar twine, by being exposed to the air and rain, will lose its smell, consequently must be renewed as occasion requires; but the mixture is always to be preferred, where it can be used.

XX.

XX. *On the Use of Oxides or Calces of Iron in dying Cotton.* By J. A. Chaptal.

FROM THE *ANNALES DE CHIMIE.*

THE oxide of iron has so strong an affinity to cotton, that if a cotton thread is dipped in a saturated solution of iron, in any kind of acid, the thread instantly acquires a buff colour, more or less deep, according to the strength of the liquor. This affinity may be shewn by the following experiment, which is both curious and easy to be made. If a skein of coton thread is dipped into a solution of green vitriol, rendered turbid by the oxide which remains suspended therein, and the cotton is moved about in the liquor, it will take up every particle of the oxide, and thereby restore to the liquor the transparency it had lost; after which, the solution, which at first had a yellowish hue, becomes more or less green, according to its strength.

The colour given to the cotton by the oxide of iron, grows darker merely by exposure to the air; and this colour, which is soft and pleasant when the

the cotton is taken from the bath, becomes harſh and ochrey by the progreſſive oxidation of the metal.

The colour given by the oxide of iron is very permanent: it not only reſiſts air and water; but alkaline leys, or ſoap, give it brilliancy, without ſenſibly diminiſhing its intenſity.

On account of theſe properties, the oxide of iron has become an eſſential ingredient in the art of dying, being conſidered as a colouring principle of the utmoſt value. I have been ſo fortunate as to extend the uſe of this oxide; but ſhall confine myſelf at preſent to ſuch reſults as have been found worthy of a place in the operations of the dyer, and have for ſeveral years been practiſed with ſucceſs in my manufactory.

In order that the oxide of iron may be conveniently applied upon the cotton thread, we muſt begin by making a ſolution of the ſaid oxide; for which purpoſe, acids are the moſt uſeful ſolvents.

In moſt places, dyers make a ſecret of the acid they employ; but it is always either the acetous, the vitriolic, the nitrous, or the marine acid.

Some dyers pretend there is a great difference in the effect of the different acids, but, in general, they give the preference to the acetous.

This preference appears to me to be founded much leſs on the difference of colour produced by

by the different ſalts, than on the different degree of corroſive power which each ſalt exerts upon the cotton. The power of the mineral acids is ſo great, that if the ſtuff is not waſhed when taken out of the bath, it will certainly be corroded; whereas, the ſolutions made in the acetous, or any other vegetable acid, are not attended with this diſadvantage.

Iron appears to be as much oxidated by being diſſolved in one acid as in the other, ſince it produces the ſame ſhade of colour when precipitated; and any acid may be employed, without diſtinction, provided the degree to which the acid is ſaturated, and the nature of the ſalt formed therewith, are ſufficiently known; for the ſubſequent operations may be regulated by the knowledge of theſe circumſtances, ſo as to avoid the inconveniences attending the uſe of ſome of theſe ſalts. This is, in the firſt inſtance, an advantage the man of ſcience has over the common workman, who knows not how to vary his proceſs according to the nature and ſtate of the ſalts he makes uſe of.

I ſhall at preſent only point out what colour may be obtained by means of the oxide of iron; firſt, when employed by itſelf, on ſtuff which has not been previouſly prepared; ſecondly, when employed, in conjunction with madder, on ſtuff

which

which has been properly prepared for receiving the Adrianople or Turkey red.

First. If sulphate of iron, or any other martial salt, be dissolved in water, and cotton be dipped in it, it will, as was before said, acquire a buff colour, more or less deep, according to the strength of the solution; and the affinity of the cotton to the iron is so strong, that it attracts the metal, and takes it in great measure from the acid in which it was dissolved.

Secondly. If iron be precipitated from a pretty strong solution, by an alkaline liquor, (of five or six degrees, by Baumé's areometer,) a coagulum of a greenish-blue colour will be formed; if cotton be macerated therein, it will immediately acquire an irregular and dirty green colour, which, by mere exposure to the air, will, in a short time, turn to a very deep yellow colour.

By these processes, or similar ones, dyers produce what are called ochre or rust colours.

But these colours are attended with several inconveniences; first, when they are very deep, they corrode or wear the stuff; secondly, this colour is harsh, and does not mix well with the soft colours produced from vegetables.

I endeavoured to remedy these inconveniences, and I succeeded in the following manner.

I soak the cotton in a cold solution of green vitriol, (of three degrees of strength,) and, having

ving wrung it carefully, I immediately plunge it into a ley of potafh, (of two degrees,) upon which I pour a faturated folution of alum. The colour then grows brighter, and becomes infinitely more fine, more foft, and more pleafant. The vitriol no longer corrodes the fubftance of the cotton, and, after it has remained four or five hours in the bath, it may be taken out to be wrung, wafhed, and dried.

In the above manner, by graduating the ftrength of the folutions, we may obtain all the fhades of colour that can be defired. This fimple procefs, the theory of which muft be obvious to every chemift, produces a colour which is very agreeable, very permanent, and, above all, very œconomical. I employ it with fuccefs in dying fuftians, &c. the colour of which is infinitely more permanent than that of the Englifh ones, having the advantage of refifting alkaline leys. The only defect I have found in the colour is, that it turns brown by the action of aftringents.

I thought, for fome time, that it might be poffible to combine this yellow colour with the blue of indigo, fo as to produce a permanent green, but hitherto I have been difappointed in my hopes. It appears, from the different trials I have made with this fubftance, that there is not a fufficient affinity between the blue of indigo

 and

and the oxide of iron; for I could never obtain any other than a dirty muddy green, very cloudy and faint.

The oxide of iron, on the contrary, combines very readily with the red of madder, and the combination produces a light violet colour, the use of which is as extensive as it is advantageous in the cotton manufactory.

But, if these two colours were to be applied to cotton, without having first employed a mordant capable of fixing the latter, the colour would not only remain dull and unpleasant, from the impossibility of brightening it, but it would also have the great defect of not being able to resist the alkaline leys. We must therefore begin by preparing the cotton as if for receiving the Turkey red; and, when the preparation is carried on as far as the operation of galling, the cotton is to be dipped into a solution of iron, more or less strong, according to the nature of the violet colour desired. The cotton is then to be carefully washed, twice dipped in a decoction of madder, and afterwards brightened in a solution of soap.

When a true violet colour, very rich and full, is required, the cotton is not to be put into the solution of iron till it has been galled: the iron is then precipitated in the form of a bluish oxide, which, when combined with the red colour of the madder, produces a very rich purple colour, more or

or lefs full, according to the ftrength of the galling, and that of the folution of iron. It is, however, very difficult to obtain an uniform colour by this procefs: indeed, an uniform violet colour is confidered by the dyers as a mafter-piece; and it is generally fuppofed, that this great difficulty, of fo much confequence in the art of dying, cannot be overcome without the moft ſkilful managenent. Neverthelefs, I am convinced, that the principal caufe of the irregularity in this dye is, that the iron depofited on the cotton becomes oxidated merely by expofure to the air, which expofure varies in different parts of the cotton.. The threads which are on the outfide of the fkein, are ftrongly oxidated; while thofe on the infide, not being expofed to the action of the air, fuffer no change. It therefore follows, that the infide of the fkein acquires a faint colour, while the outer part acquires a very dark violet. The only way to prevent this inconvenience is, to wafh the cotton when it is taken from the folution of iron, and to put it into the decoction of madder while yet moift. The colour thereby becomes more uniform, and more rich.

The folvents of iron, for this colour, are nearly the fame as for the yellow colour already mentioned.

I ſhall omit every thing reſpecting the manual operations of the proceſs, and ſhall confine myſelf merely to the chemical ones; for which reaſon, I ſhall mention an obſervation which may ſerve as a guide to the workman, in brightening the violet colour upon cotton.

The red of the madder and the oxide of iron, by being depoſited on the cotton, produce a violet colour. This colour inclines to red, or blue, as one or the other of theſe two principles predominate. The dyer knows, by experience, how difficult it is to obtain ſuch a combination as will produce the ſhade of colour he deſires, eſpecially when he wiſhes it to be very full, brilliant, and permanent. It may, however, be obtained, not only by varying the proportions of the two colouring principles, but alſo by varying the proceſs of brightening. It is only neceſſary to be acquainted with the two following circumſtances, *viz.* that barilla deſtroys the iron; and that ſoap, by ſtrong boiling, conſumes the colour of the madder. For this reaſon, the colour may be made to incline to red, or to blue, according as the brightening is performed with one or the other of theſe mordants. Thus, cotton taken from the madder-bath, waſhed, and brightened with a proper quantity of ſoap, will be of a rich violet colour; whereas, by brightening it with barilla, we ſhall obtain only a light violet colour.

The

The oxide of iron, when precipitated on any ſtuff, combines very advantageouſly with the fawn colour furniſhed by aſtringents; and, by varying the ſtrength of the mordants, an infinite number of ſhades may be produced. In this caſe, the reſult is rather a ſimple mixture, or juxtapoſition, of the colouring particles on the ſtuff, than a chemical combination or ſolution of principles. We may indeed, by a boiling heat, combine the oxide of iron more intimately with the aſtringent principle; it is then brought into the ſtate of a black oxide, as Berthollet has obſerved.

It is poſſible alſo to turn theſe colours brown, and to give them a variety of ſhades, from a light grey to a deep black, merely by dipping the cottons, impregnated with the aſtringent principle, into a ſolution of iron. The oxide itſelf is then precipitated by the aſtringent principle, which is fixed upon the ſtuff.

A circumſtance which may become of great importance to the art of dying is, that all the moſt uſual vegetable aſtringents afford a yellow colour, which, although it is not very bright, is ſufficiently durable to be advantageouſly employed. This yellow colour in vegetables is capable of being brightened in proportion as the aſtringent principle diminiſhes, and the livelineſs of the colour increaſes in the ſame proportion. It

is,

is, on this account, difficult to obtain yellow colours which are at the ſame time durable and brilliant; theſe two valuable qualities being in an inverſe ratio to each other. But it is poſſible to mix theſe two colouring principles in ſuch a way as to unite durability to brilliancy. Green oak-bark unites perfectly well with woad or yellow weed, (Reſeda Luteola;) and ſumach unites well with quercitron* bark. From ſuch mixtures, in combination with the oxide of iron, we may produce vegetable colours, the brilliancy of which is equal to their durability.

I ſhall conclude theſe reflections with an obſervation relative to the uſe of aſtringents in dying cotton:

It has been ſuppoſed that, in dying cotton red, the place of galls might be ſupplied by an increaſed quantity of ſumach, alder-bark, or oak-bark. I wiſh this were the caſe, as the high price of galls very much enhances the expence of the colours dyed with them; whereas I could procure ſumach at a low price, as it grows almoſt every where in the dry parts of our ſouthern provinces; but I can affirm, that it is impoſſible to ſupply the place of galls with theſe ſubſtances, in whatever proportion they are employed; the

* A name given by Dr. Bancroft to a ſpecies of American oak.

colour

colour produced from them being always more pale and faint, and leſs permanent. I know that what is here ſaid does not apply to dying wool and ſilk, for which the above ſubſtances are ſucceſsfully employed; and, upon conſidering the cauſe of this difference, it appears to me to ariſe from the nature of the galls. In the firſt place, the acid they contain is different from that of other aſtringents, (as Berthollet has proved,) and facilitates the decompoſition of the ſoap with which the cotton is impregnated; hence, a greater quantity of oil remains fixed in the ſubſtance of the cotton, and is more intimately combined with it. Secondly, galls, being produced by means of inſects, always retain a certain degree of animal nature, which they impart to the cotton, thereby increaſing its affinity to the colouring principle of the madder. The uſe of animal ſubſtances in facilitating this combination is well known; but wool and ſilk being themſelves animal ſubſtances, it is unneceſſary, in operating upon them, to make uſe of galls.

XXI. *Instructions respecting the Manner of making Paper afresh, from Leaves of Books, Letters, or any other Paper that has been printed or written on. Published, by order of the National Convention, by Messrs.* DEYEUX, MOLARD, PELLETIER, *and* VERKAVEN.

FROM THE *ANNALES DE CHIMIE.*

IN consequence of some experiments which proved the possibility of obtaining paper of a good quality, by the re-fabrication of paper which had been printed or written on, we have thought it right to publish the following instructions, in which we have collected together those processes which appeared the most convenient for obtaining the end proposed.

Processes for the Re-fabrication of printed Paper.

First Process.

1. All paper of the same quality is to be collected into one parcel, (as far as it is possible to do

do so,) from which, all that has any writing upon it is to be carefully separated.

2. The edges of those leaves which, from age, or any other cause, are become yellow, are to be cut off, by means of the instrument used by the book-binders; so likewise are those upon which any colour has been applied.

The backs of books, on which there generally is glue and packthread, are to be treated in the same manner.

3. Several wooden tubs are to be placed in such a manner that the workmen can move freely about them, and have room to stir continually the matter put into the tubs.

Each tub should be sufficiently large to contain at least one hundred pounds of paper, and five hundred quarts of water. At about three inches from the bottom is to be fixed a pipe, for drawing off the water, the interior orifice of which is to be covered with a piece of tinned copper, pierced full of holes, so as to permit the water to run off, without bringing any of the paper with it.

4. At a small distance from these tubs (over a proper fire-place) is to be fixed a copper caldron, tinned on the inside, and of a sufficient capacity to contain the water with which it is intended to fill the tubs.

5. By the side of this caldron (and also o er a fire-place) are to be placed two other caldrons

of tinned copper, in which the paper is to be boiled with the caustic ley, hereafter described. These two caldrons, which are to be of a smaller size than the first, are to be so placed that their inside may be conveniently seen, and that the matter contained within them may be stirred.

6. After having filled the tubs about one-third part full of water, almost boiling, the paper intended to be made up afresh is to be thrown in, sheet by sheet.

Two workmen, placed opposite to each other, with long wooden paddles, are to press down and stir about the sheets of paper, as they fall into the tubs; they are to continue stirring them for the space of an hour, and to add such a quantity of water as will rise about three inches above the paper.

7. The whole is to be left to macerate for four or five hours, taking care to stir it from time to time, and always strongly, so that the paper may be divided, and brought into a kind of paste.

8. The water is then to be drawn off, by means of the pipe already spoken of: the discharge of the water may be promoted by gently pressing the paste with the wooden paddles, or any other convenient instrument.

9. The paste remaining after this operation is to be carried to the mill, and to be ground (not

very

very finely) under the roller, for about an hour; after which it is to be taken away, and carried to the ſmall caldrons already mentioned.

10. The paſte is to be gently boiled in them for about an hour, with a ſufficient quantity of water to riſe four or five inches above it. A little before the boiling begins, thirteen quarts of cauſtic ley of potaſh (prepared as hereafter deſcribed) are to be added to every hundred pounds of paper made uſe of.

During the whole time of the boiling, the matter is to be continually ſtirred, taking particular care that it does not ſtick to the bottom of the caldron.

If the cauſtic ley has been carefully made, and with very good potaſh, a leſs quantity than that above mentioned may perhaps be ſufficient; for inſtance, two quarts of the ley may be reſerved, to be added a quarter of an hour before the boiling is finiſhed, in caſe the eleven quarts firſt uſed ſhould appear to have been inſufficient to produce the deſired effect.

11. When the boiling has continued the forementioned ſpace of time, the fire is to be put out, and the matter is to be left to macerate in the caldrons for twelve hours.

12. The paſte is then to be taken out of the caldrons, by the help of large ladles pierced full of holes, like colanders; and, after having been

drained in open baskets, it is to be put into bags, made of linen, or any other proper material, to be afterwards submitted to the action of a strong press.

13. The liquor which runs from the bags during the pressure, and also that which remained in the caldrons, is to be preserved; and, when a sufficient quantity of such liquor has been collected, it may be evaporated to dryness in iron vessels. By well calcining the residuum, a quantity of fresh potash will be obtained, which may be made use of for various purposes, as circumstances shall direct.

14. The matter remaining in the bags, after being pressed, is to be divided into different portions, and carried immediately to be ground fine under the roller; a full hour, or more, if found necessary, may be employed in this operation.

15. A small quantity of paste must be taken out from time to time; and, after pressing it in the hands, it may be examined, to see whether it is sufficiently divided, and whether the printing-ink is well separated from it.

16. It will be known when the operation is nearly finished, by the white colour of the paste.

17. Lastly, when it appears that it is brought into a proper state, the roller may be stopped, and the paste may be carried to the vat of the workmen who are to make it into paper.

Second Procefs for printed Paper.

After having taken the glue, &c. from the paper, in the manner already defcribed, it is to be put into the caldron, with the above-mentioned quantity of cauftic ley of potafh. The matter is to be continually ftirred, as long as it is kept boiling; and, after being macerated in the liquor for twelve hours, may be taken out. It is then (without having the liquor preffed out of it, yet not in too moift a ftate) to be put into a wooden veffel, in which, by means of a machine which will be defcribed hereafter, it is to be beaten and mafhed, until it acquires a black colour, and all appearance of letters is entirely obliterated.

If, during this operation, the pafte fhould grow too dry, it muft be moiftened, from time to time, with the liquor which remained in the caldron.

When this operation is finifhed, the pafte is to be ground under the roller, for about two hours, or till it is fufficiently fine; it may then be made into paper.

Another

Another Manner of performing the above Processes.

In the two processes already described, caustic ley of barilla may be used, instead of the ley of potash; observing only, that about one-third more of barilla-ley will in general be necessary. This, however, depends upon the quality of the barilla; for, if that contain a great proportion of alkaline salt, the quantity above-mentioned will be too great.

Experience, however, will shew exactly the quantity of caustic barilla-ley necessary to be used; which quantity will be always determined by the state of the paste, during the boiling, and afterwards.

Observation.

If, in consequence of the preceding operations, the paste should appear to be too brittle, it may be mixed (before the grinding is finished) with an eighth, a sixth, a fourth, or even a third part, of fresh paste, (made of rags,) well divided, and of a good colour.

This addition will improve the paste, and give it a better consistence; but in general it is unnecessary.

TO BE CONCLUDED IN OUR NEXT.

XXII. *List of Patents for Inventions, &c.*

(Continued from Page 72.)

William Pontifex, of Shoe-lane, in the city of London, Copperſmith, (with the aſſiſtance of his brother; for an improved ſtill-head, for diſtilling all ſorts of liquors. Dated November 17, 1798.

John Curr, of Sheffield Park, in the pariſh of Sheffield, in the county of York, Gentleman; for a method of forming and making a flat rope, intended to be uſed in drawing coals, and other minerals, and water, out of pits or mines of any kind. Dated November 17, 1798.

Nathan Smith, of Brighthelmſtone, in the county of Suſſex, Gentleman; for a method of conſtructing or making a vapour-bath or veſſel, of different ſizes and ſhapes, by uniting thereto, and uſing therewith, a machine called an air-pump or exhauſter, for curing, healing, and relieving, perſons afflicted with the gout, &c. Dated November 20, 1798.

George

George Dunnage, of the Strand, in the liberty of Weftminfter, Hat-maker; for a manner of ventilating the crowns of hats, which is much fuperior to any now ufed for that purpofe. Dated November 27, 1798.

Robert Hindmarsh, of Walworth, in the county of Surrey, Printer; for a method of applying an elementary or phyfical power to blaft furnaces, and for all other works where power is required. Dated November 27, 1798.

Mark Noble, of Royal-row, in the parifh of St. Mary, Lambeth, in the county of Surrey, Engine-maker; for an apparatus to be applied to the working of pumps, engines, or machines in general, whether for fea or land fervice. Dated November 27, 1798.

Nathaniel Godbold, of Bloomfbury-fquare, Efquire; for a remedy which is of wonderful benefit in the cure of confumption, fcrophula, and gout. Dated November 27, 1798.

ERRATUM.

In our laft Lift of Patents, page 71, *for* Greufell *read* Grenfell.

Printed by Nichols and Son, Red-Lion-Paffage, Fleet-Street, London.

REPERTORY

OF

ARTS AND MANUFACTURES.

NUMBER LVII.

XXIII. *Specification of the Patent granted to Mr.* JOHN RICHARDSON, *of the Parish of St. Giles in the Fields, Optician; for his Invention of a Machine, or Machines, to be applied to Glasses and Pebbles of every Description, for the Use of Sights in general.*

WITH A PLATE.

Dated July 4, 1797.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said John Richardson do hereby declare, that my said invention is described in the drawing and description hereunto annexed. In witness whereof, &c.

Explanation of the Figure.

(See Plate IX. Fig. 1.)

The drawing reprefents a pair of common glaffes, with my machines (with different glaffes therein) applied or affixed thereto, and fo conftructed as to fhut over the other glaffes with eafe, when a different fight is required.

A, reprefents one machine, as open.

B, the other, as fhut.

C, C, are joints, fixed to the infide of the knuckle of the machines, by which the machines open and fhut at pleafure.

One great utility, among others, of my invention is, that it precludes the neceffity of two pairs of fpectacles; as any two diftinct fights, for any purpofe whatever, may be adopted, agreeable to the wifhes of the wearer.

XXIV.

XXIV. *Specification of the Patent granted to Mr.* STANLEY HOWARD, *of St. Paul's Church-Yard, Ironmonger; for his Invention of a Machine which he calls the* Pneumatic Kitchen, *for cooking Victuals by Steam, in ſuch a Way that no complex Machinery is required for ſupplying the Boiler with Water, to replace the Quantity expended by Evaporation, nor any Pump, (the Boiler being conſtantly ſupplied, during the Evaporation, without the Aid of a Ciſtern;) which Machine may be fixed up, at a ſmall Expence, without any Injury to the Houſe, or Alteration of the Chimney, and, when once fixed, requires no repair; and ſuch Machine hath never before been diſcovered.*

WITH A PLATE.

Dated Dec. 21, 1793.

TO all to whom theſe preſents ſhall come, &c. Now KNOW YE, that in compliance with the ſaid proviſo, I the ſaid Stanley Howard do hereby declare, that the nature of my ſaid invention, and in what manner the ſame is to be performed, is particularly deſcribed and aſcertained in the annexed plan or drawing, and in the following

 explanation

explanation and deſcription of ſuch plan or drawing, referring thereto. In witneſs whereof, &c.

DESCRIPTION of the forementioned PLAN or DRAWING. (See Plate IX. Fig. 2.)

The ſteam-boiler and cooking veſſel, being made in the uſual way, ſuch boiler is to be ſupplied with water by a fountain-reſervoir, marked A, which is to be placed at a convenient diſtance therefrom, with its diſcharging tube, marked B, inverted in a ciſtern or pipe, marked C; in which ciſtern or pipe, the ſurface of the water will, by means of the fountain, be preſerved always at one height, marked D; and, by a communication, marked E, from the ſaid ciſtern or pipe, with the ſteam-boiler, marked F, the water therein, during the evaporation, will be preſerved at a height correſponding with ſuch ciſtern or pipe, and always at the ſame level, marked G. By means of the ſaid fountain, the neceſſity of cocks and pipes, or pumps, for ſupplying the boiler, is removed; and the ſupply rendered more immediate, more certain, and more ſimple, than by any method hitherto uſed. The ſaid fountain may be made of any materials, or in any form, ſuited for the purpoſe.

XXV.

Fig. 1.

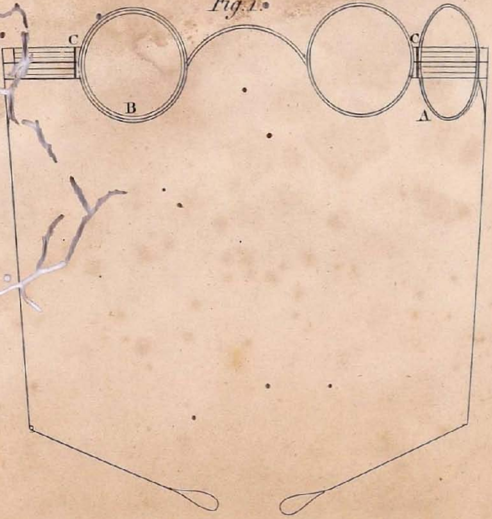
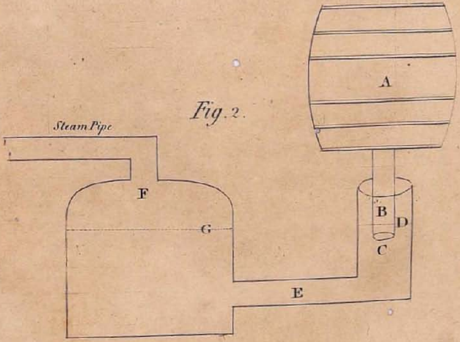


Fig. 2.



XXV. *Specification of the Patent granted to Mr.* GEORGE DUNNAGE, *of the Strand, in the Parifh of St. Martin in the Fields, Weftminfter, in the County of Middlefex, Patent Silk Hat-maker; for his Invention of a Method of ventilating the Crowns of Hats.*

WITH A PLATE.

Dated Nov. 27, 1798.

TO all to whom thefe prefents fhall come, &c. Now KNOW YE, that I the faid George Dunnage, in compliance with the faid provifo, do hereby defcribe and afcertain the nature of my faid invention, and declare, that the fame confifts in feparating, or (if hats be made for the purpofe of my invention) of keeping feparate, the tip or top-crown, from the fide-crown of the hat, and partly or wholly raifing or fhutting down the tip or top-crown, from or to the fide-crown, fo as to admit the external air to circulate freely in the interior of the crown of the hat; or to exclude the fame, by means of fprings, fliders, ftaples, fockets, grooves, loops, and cafes, or fome

ſome or any of them, connected to or with the tip or top and ſide crown, and thereby to regulate the admiſſion or excluſion of the external air in front, behind, or on either ſide, as may be found moſt agreeable to the wearer.

And I do hereby ſpecify and declare, that the ſame is now performed by me, in the following manner; that is to ſay: I make ſprings and ſliders, of the form and ſhape reſpectively deſcribed in the drawings and explanations hereto annexed, and marked 1 and 2, (ſee Plate X.) of whalebone, metal, or any other convenient ſubſtance. The ſtaples or ſockets, which are intended for the reception of the ſprings, (and which are alſo deſcribed in ſuch annexed drawings and explanation, and diſtinguiſhed by Figs. 3, 4, and 5,) I form of thin metal. I then faſten or affix, in the manner hereafter deſcribed, a convenient number of the ſaid ſtaples or ſockets, to a thin fillet or hoop, made of linen, canvaſs, cotton, or other material, ſufficiently ſtiffened to ſupport the ſprings, ſliders, ſtaples or ſockets, grooves, and loops, mentioned to be attached thereto. And, in the intermediate ſpace, left between the ſaid ſtaples or ſockets, I ſew pieces of tape, or narrow ribbon, canvaſs, or cloth, on the ſaid fillet or hoop, in the form of a ſmall groove, loop, or caſe, to receive the ſliders hereafter mentioned.

I have

I have found four ſprings, and an equal number of ſliders, to anſwer my purpoſe. Or, inſtead of uſing four ſprings and four ſliders, I uſe ſix, or more, ſprings only; fixing an equal number of grooves or ſockets on the hoop or fillet, to receive them, and omit the loops or ſtaples. Or, I uſe ſix or eight ſliders only, and attach an equal number of loops and ſtaples to the hoop or fillet, omitting the grooves or ſockets. Either of theſe methods may be adopted, as may appear moſt convenient to the manufacturer.

I then (by means of glue, or other adheſive ſubſtance) faſten the ſaid fillet or hoop, with ſuch ſtaples or ſockets, grooves, loops, or caſes, or any or either of them, fixed thereon, to the interior ſurface of the ſide-crown of the hat, and very near to the top edge of it. I then ſew as many pieces of tape, narrow ribbon, canvaſs, or cloth, in the form of grooves or caſes, on the under ſide of the tip or top-crown, (and in a direction from the edge towards the centre,) as there are ſtaples or ſockets, grooves, loops, or caſes, on the fillet or hoop, in ſuch parts thereof as will correſpond with the ſtaples or ſockets, grooves, loops, or caſes, placed on the fillet or hoop. Into theſe grooves or caſes, ſo affixed to the under ſide of the tip or top-crown, that part of the ſpring or ſlider which in the annexed drawing is marked A A, is to be forced. I then

put

put and paſs the ends of the ſprings and ſliders through the ſaid ſtaples or ſockets, grooves, loops, or caſes, provided for their reception on the fillet or hoop; and compleat the operation by crooking, or turning upwards, the ends of the ſliders, and turning in the piece of metal, which is prepared for that purpoſe, by a notch or ſlit in the ſides of the ſtaples or ſockets which receive the ſprings, as may be ſeen in the annexed drawing, Figs. 4 and 5; by which means, the ſprings and ſliders, or ſprings, or ſliders, when they are ſeparately uſed, are prevented from being entirely diſcharged or drawn out, upon elevating the top-crown of the hat.

EXPLANATION of the DRAWINGS above referred to. (See Plate X.)

Fig. 1. A ſpring, made of whalebone or other material. A A, the part which is to be attached or forced into the grooves or caſes, under the tip or top-crown. B B, the part which is to be attached to the ſide-crown, by means of a ſtaple or ſocket, affixed to the fillet or hoop before mentioned.

Fig. 2. A ſlider. A A, the part which is to be attached or forced into the grooves or caſes, in, or under, the tip or top-crown. B, the part which is to be attached to the ſide-crown, by means

means of a groove or cafe, affixed to the fillet or hoop before mentioned.

Fig. 3. A front view of a groove or focket, made of thin metal, or other material, in which the above mentioned fpring is to move. A, A, A, A, four corners or bits of metal, left above and below the body of the groove or focket, which, being turned back, two of them over, and two of them under the fillet or hoop, ferve to faften it on to the faid fillet or hoop, in manner as feen at C, C, Fig. 4.

Fig. 4. A fide view of the ftaple or focket meant for the reception of the fprings, as faftened to the fillet, with the fpring A A A in it. B, body of the ftaple or focket. C, C, corners of the fame, (as at A, A, A, A, Fig. 3,) turned over and under the fillet. D, a fmall notch or flit in the lower fide of the ftaple or focket.

Fig. 5. Is an oblique view of the ftaple or focket meant for the reception of the fpring, placed in fuch a point of view as to fhew the notch or flit D, which is made for the purpofe of turning the point thereof inwards, through the bend or curve of the fpring, thereby to prevent the faid fpring being drawn too far out or dif-charged, upon elevating the tip or top-crown of the hat.

Fig. 6. Is the fection and interior view of a hat, with the top elevated. A, tip or top-crown. B, fide-

B, ſide-crown. C, fillet or hoop, with the ſtaples or ſockets, grooves or loops, fixed thereon.

Fig. 7. The like ſection and view of a hat, with a part only of the top-crown elevated; the reſt remaining in contact with the ſide-crown.

The ſprings, ſliders, ſtaples or ſockets, and grooves, loops, or caſes, above deſcribed, are ſuch as, after a number of experiments, I have found beſt to anſwer the object of my invention; but it is obvious that ſprings, ſliders, ſtaples, ſockets, grooves, loops, and caſes, may be made in a great variety of forms, and of various materials, to produce the effect of my invention. I therefore repeat, that it is the *elevation* or *depreſſion*, or *partial elevation* or *depreſſion*, of the tip or top-crown of the hat, by means of ſprings, ſliders, ſtaples, ſockets, grooves, loops, and caſes, or ſome or any of them, which I claim as my invention, more than any particular form, or combination, or application, of ſuch ſprings, ſliders, ſtaples, ſockets, grooves, loops, or caſes, which I have adopted, as the means or agents for producing the effect of my ſaid invention. Theſe means, I conceive, I am at liberty to vary, and excluſively to apply, as experience ſhall point out, provided I ſtrictly adhere to the manner of ventilation above ſpecified. In witneſs whereof, &c.

XXVI.

Fig. 1.

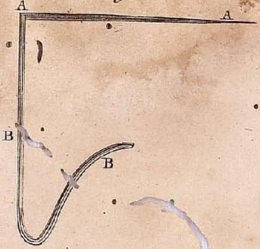


Fig. 2.

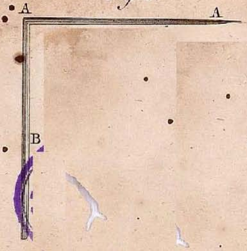


Fig. 3.

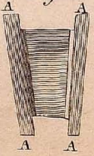


Fig. 4.

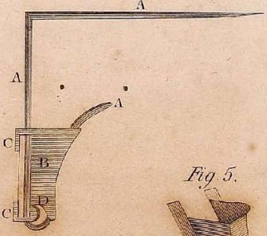


Fig. 5.

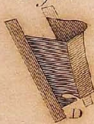


Fig. 6.

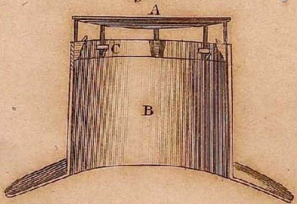
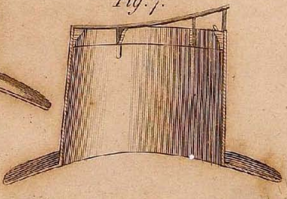


Fig. 7.



XXVI. *Specification of the Patent granted to Mr.* WILLIAM RALEY, *of Newbald, in the East-Riding of Yorkshire, Chemist; for his Invention of a Philosophical Furnace and Boiler, with an actuating Wheel, being an Appendage to the said Philosophical Furnace and Boiler; and which Invention is applicable to drawing foul and inflammable Air from Pits, Mines, &c. and to several Branches of Pharmacy, and various mechanical Purposes.*

Dated Dec. 8, 1798.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said William Raley do hereby declare, that my said invention is described in manner following; that is to say: The above-mentioned boiler, of any size, is made of copper, iron, or other metal, as thought proper; the form or shape of which is either circular, square, oblong, or otherwise, as may be found necessary, or most convenient. The dimensions of the boiler may be in the following proportions,

 viz.

viz. ſuppoſe a circular or round boiler is ſix feet high or deep, from its top or rim, which reſts or hangs on the furnace; its width or diameter at its top or rim, five feet; and its diameter at bottom, three feet; adding about one foot and a half more, in height, (above its rim,) for the convex or outer part of its cover, as in common boilers for ſteam-engines. And, with an intent to increaſe the quantity or force of ſteam, the whole, or as much as poſſible of the inſide, of the boiler (above the level of the water in its bottom,) is to be kept wet with water, by means of certain cells, cavities, aqueducts, troughs, tubes, or other contrivances, being placed in the inſide of the boiler, to contain a quantity of water above the level of that in its bottom. And, to convey the ſaid water to the extremity of the inſide of the boiler, above the level of that in its bottom, a contrivance with cells is effected in the following manner, *viz.* divide the whole circumference or inner extremity of the boiler, (from its top to the bottom,) into a number of equal parts or diviſions, by narrow pieces of copper, (or other metal,) from one to four inches broad, or more, according to the ſize of the boiler; which pieces are to be fixed to its ſides: the number of the above-mentioned parts or diviſions may be from eight to ſixteen, more or leſs, according to the ſize of the boiler. In each of theſe diviſions (beginning near

near the top or rim of the boiler) are placed pieces of thin copper, or other metal, each piece reaching from one partition to another; which pieces ſtand perpendicular edge-wiſe round the inſide of the boiler. The bottom or lower edge of which pieces are joined to, or brought into contact with, the inſide of the boiler, ſo as to form a circle, or kind of hoop, round the extremity of the inſide of the boiler. Hence, the above-mentioned thin pieces of copper, or other metal, being thus arranged, form a kind of cells, ſo as to contain a portion of water in each cell. The above-mentioned circular or hoop-like arrangement of cells, ſhould be continued (at certain diſtances) from near the top or rim of the boiler, down to its bottom, or nearly ſo. At the end of each of the above-mentioned cells (cloſe to each partition) is a ſmall hole, to let out the water, ſo that it may fall into another circle or hoop-like arrangement of cells, placed below. Theſe holes are at one end of thoſe cells, contained in one circular or hoop-like arrangement thereof, and at the other end of thoſe contained in the next circle, &c. &c. Hence the water, in its deſcent, runs firſt one way and then the other, thereby forming a kind of ſerpentine motion in each diviſion. The diſtance theſe circular or hoop-like arrangements of cells are one from the other, may be about one foot, more or leſs, according to the ſize of the boiler.

In

In case they are at the distance of one foot, the above-mentioned thin pieces of copper, or other metal, need only be about half a foot broad. The above-mentioned cells (or other contrivances) are supplied with water, either from that within the boiler, or from some reservoir, or other containing vessel, on the outside thereof. They are supplied with water from without the boiler, by tubes from a close reservoir of water, placed a convenient height above the level of the boiler; each tube having a cock, or kind of valve, so as to let a due quantity of water into the cells in each division, within the boiler. A steam-tube being placed from the said close reservoir to the boiler, to preserve an equal balance of power of the steam in each of the two vessels. The above-mentioned close reservoir may (for a boiler of the same dimensions) be about one foot and a half high or deep, three feet in diameter at its top, and two feet and a half in diameter at its bottom. The water is thrown either into the above-mentioned close reservoir, or boiler, by a pump, worked by the force of steam, or otherwise, (from the hot well, or other convenient place); or by a tube, from an open cistern or reservoir, whose height, above the said close reservoir, is so high, that the water therein may be more than sufficient to counterbalance the strength of the steam in the close reservoir and boiler. The

The above-mentioned tube has a cock or valve, to let the water into the cloſe reſervoir, or boiler; which cock or valve is regulated by a float, or other contrivance. The water in the above-mentioned cloſe reſervoir, is made boiling hot, by placing the ſaid reſervoir over the vents or chimneys of the furnace. The above-mentioned cells, or other contrivances, are ſupplied with water from within the boiler, by a ſmall pump, placed within the boiler, by which the water is raiſed into a kind of open reſervoir, within the boiler; from which it is conveyed, by tubes, or open aqueducts, to thoſe parts where it is wanted. The rod or ſhaft of this pump (which actuates its bucket or piſton) paſſes through a packed collar, in the centre of the boiler's cover. Or, inſtead of a pump, the water within the boiler is conveyed into the cells, or other contrivance, by a kind of ſpoons, or other ſmall veſſels, placed at the extremity of ſmall pieces of iron, or other metal, croſs-wiſe, or in a ſtar-like poſition, where they are to act as types. From the centre of theſe ſmall pieces of iron (where they croſs each other) is a rod or ſhaft, the ſame as the pump, whereby the ſtar-like arrangement of ſpoons, or other ſmall veſſels, are made to deſcend and aſcend. By their deſcent they are filled with water; and in their aſcent they are emptied into the cells, cavities, aqueducts, &c. their tails

or

or types ſtriking againſt a kind of rim or hoop, or other contrivance, for that purpoſe. The height of the water in the boiler is adjuſted or regulated by a common balance-float, or other contrivance, as in common boilers belonging to ſteam-engines. If the water in the boiler becomes too high, or too much in quantity, it is to be diminiſhed by ſtraightening the cocks or valves of the tubes deſcending from the reſervoir which ſupply it: and if the water is too low, they muſt be widened. And, in caſe the water is much too high, (through inattention,) it is to be diminiſhed by opening a ſmall cock or valve, placed near the bottom of the boiler, or by means of a ſyphon, with its cock or valve. If the ſize of the boiler is very large, the quantity or force of ſteam therein may be more increaſed by raiſing its bottom concave next the fire, ſo that it becomes conical, broad at its baſis, (*viz.* about two-thirds of the diameter of the boiler's bottom,) and terminating at its apex in a ſmall tube, paſſing through the cover of the boiler, (ſo as to give the heat a little vent,) and terminating in the cavity under the cloſe reſervoir. The above contrivance may either be conical, (as above deſcribed,) pyramidical, angular, &c. according to the ſhape of the boiler; around which are placed cells, cavities, aqueducts, tubes, &c. the ſame as thoſe round the inner extremity of the boiler, and ſupplied with water

either

either from within or without the boiler, by the ſame pump, or reſervoir, placed a ſufficient height above the boiler, as above obſerved. Steam, produced by means of the above-mentioned philoſophical boiler, is applicable to ſteam-engines, and other mechanical purpoſes, and to various branches of pharmacy, &c. by its being admitted into double pans, ſtills, or other proper veſſels. The furnace in which the philoſophical boiler is fixed, is of the ſame ſhape as the boiler, and about four or five inches (more or leſs, according to the ſize thereof,) wider in diameter, ſo that the boiler may hang therein by its top or rim, leaving a kind of cavity, or narrow flue, for the heat to act uniformly round the whole of the boiler to its top or rim. From the above flue the heat is to aſcend, by four or more flues or chimneys, (in oppoſite direction,) cloſe by the top or rim of the boiler. Theſe flues or chimneys are to incline (arch-wiſe) over the top of the boiler; where, meeting, they are to form an opening or cavity, in which the cloſe or undermoſt reſervoir is to be hung; from which the heat is to aſcend by three (or more) ſmall flues or vents, (placed in an angular or oppoſite direction,) cloſe by the rim or top of the ſaid reſervoir, until they riſe above it, where they are to meet, and form one common chimney. The aſh-hole and fire-place to be made ſo that the air

may not enter in at the front, or one ſide of the aſh-hole only, (as is common,) but in different directions, ſo as to meet under the centre of the fire, which is to be directly under the centre of the boiler's bottom. Where the above-mentioned furnace is uſed as a ventilator, there need only be one opening in the front of the aſh-hole, which muſt have a door, the ſame as the fire-place; both of which are to ſhut as cloſe as poſſible, to prevent the air's acceſs, the fire being wholly ſupplied therewith by tubes entering different parts of the aſh-hole, with their ends inclining, to prevent the aſhes, &c. from entering. The lower ends of the ſaid tubes join a large tube, at the outſide of the aſh-hole; the lower end of which tube terminates in the pit, mine, &c. where it is divided into a number of ſmaller tubes, extended to different parts thereof, ſo as to attract or draw air and vapours therefrom; a cock or damper being placed near the top of the large tube, to regulate the air neceſſary for the fire. It may at times be neceſſary to open the door of the aſh-hole a little, to aſſiſt in ſupplying the fire with more air. If the engine (to which the above philoſophical furnace and boiler are applied) raiſe a conſiderable quantity of water, the ſaid water is made to aſſiſt in the act of ventilation, by letting it into a cloſe veſſel, having three tubes from its upper part; one to let in the

water

water from a reſervoir, (into which the engine has raiſed it;) another to let out the air; and the third, (which deſcends into the pit, mine, &c.) to draw air and vapours therefrom; alſo another tube, from its bottom, to let out the water; each of which tubes has a cock. Suppoſe the above veſſel empty, and the cocks cloſed: open the cocks of two of the uppermoſt tubes, *viz.* that for letting in the water from the reſervoir, and the other for letting out the air, and the water will enter the veſſel, and diſcharge the air by the other tube. When the veſſel is full of water, cloſe the cocks of the two tubes laſt mentioned, and open thoſe of the other two; ſo will the water run out of the veſſel, which will be filled with air and vapours, from the pit, mine, &c. The above cocks are opened and cloſed by the action of the engine, or otherwiſe: hence, by two or more of the above veſſels, a conſtant and regular diſcharge of air and vapours is effected. Where the water, raiſed by the engine, is not employed in the act of ventilation, it may be applied to the following actuating wheel, of a kind of tubular conſtruction, as follows: A tube of copper, or other ſubſtance, whoſe diameter and length is according to the quantity of water raiſed and the height of its fall, being wideſt at its top, to receive the water, as it ſtands perpendicular on the

point of an axis, paſſing through its centre. The bottom of the ſaid tube is (towards its extremity) cut into a number of diviſions, or kind of fans, reſembling the fly of a ſmoak-jack, or common ventilator, placed in windows, doors, &c. The water paſſing through the openings, between the fans, cauſes the tube to have an horizontal motion. Above the tube (on its axis) is a ſmall wheel, applicable to pumps, or other devices, which require motion. In witneſs whereof, &c.

We are deſired by the Patentee to ſay, that any farther particulars, reſpecting the above invention, may be had by applying to him, at Newbald, near Market-Weighton, in the Eaſt-Riding of Yorkſhire; or to Mr. Rowntree, engine-maker, on the Surrey ſide of Blackfriars Bridge.

XXVII. *On the Procefs of Bleaching with the oxygenated muriatic Acid; and a Defcription of a new Apparatus for bleaching Cloths with that Acid diffolved in Water, without the Addition of Alkali.* By THEOPHILUS LEWIS RUPP.

From the MEMOIRS of the LITERARY and PHILOSOPHICAL SOCIETY of MANCHESTER.

THE arts which fupply the luxuries, conveniencies, and neceffaries of life, have derived but little advantage from philofophers. A view of the hiftory of the arts will evince the juftice of this obfervation. In mechanics, for inftance, we find that the moft important inventions and improvements have been made, not through the reafonings of philofophers, but through the ingenuity of artifts, and not unfrequently by common workmen. The chemift, in particular, if we except the pharmaceutical laboratory, has but little claim on the arts: on the contrary, he is indebted to them for the greateft difcoveries, and a prodigious number of facts, which form the bafis of his fcience. In the difcovery of the art of making bread,

bread, of the vinous and acetous fermentations, of tanning, of working ores and metals, of making glaſs and ſoap, of the action and application of manures, and in numberleſs other diſcoveries of the higheſt importance, though they are all chemical proceſſes, the chemiſt has no ſhare. But no branch of the uſeful arts is leſs indebted to him, than that of changing the colours of ſubſtances. The art of dying has attained a high degree of perfection, without the aid of the chemiſt, who is totally ignorant of the rationale of many of its proceſſes, and the little he knows of this ſubject is of a late date. The proceſs of dying the Turkey red, has been known and practiſed from time immemorial, by the moſt uncultivated nations, but its theory is not yet underſtood by philoſophers. The manufacture of indigo, and its application, have been long known to the planter and the dyer; but it is not more than ten years ſince a true theory of them has been formed. The art of printing, or topical dying, is of the greateſt antiquity; but the theory of this proceſs, and of adjective colours in plain dying, was unknown, till Mr. Henry developed it in the Memoirs of this Society *. He was the firſt who thought and wrote philoſophically on this ſubject. The bleaching or whitening

* Mr. Henry's paper on dying is printed in our ſecond volume, page 41.

of

of vegetable ſubſtances has been long practiſed; but the knowledge of its theory could not be antecedent to the æra of pneumatic chemiſtry. We might, even at this moment, have been unacquainted with the cauſe of the deſtruction of the colouring matter of vegetable ſubſtances, if the diſcovery of the oxygenated muriatic acid, and its effects on colouring matter, had not pointed it out to us. For this diſcovery, and its ineſtimable advantages, the arts are indebted to the juſtly celebrated Scheele; and I am happy to pay this tribute to chemiſtry, after the mortifying truths which I have ſtated above.

M. Berthollet loſt no time in applying the properties of this curious and highly intereſting ſubſtance to the moſt important practical uſes. His experiments on bleaching with the oxygenated muriatic acid proved completely ſucceſsful, and he did not delay to communicate his valuable labours to the public. The new method of bleaching was quickly and ſucceſsfully introduced into the manufactures of Mancheſter, Glaſgow, Rouen, Valenciennes, and Courtray; and it has ſince been generally adopted in Great Britain, Ireland, France, and Germany. The advantages which reſult from this method, which accelerates the proceſs of whitening cottons, linens, paper, &c. to a really ſurpriſing degree, in every ſeaſon of the year, can be juſtly appreciated by commercial people

people only, who experience its beneficial effects in many ways, but particularly in the quick circulation of their capitals.

Great difficulties, for a time, impeded its progrefs, arifing chiefly from prejudice, and the ignorance of bleachers in chemical proceffes. Thefe obftacles were, however, foon removed, by Mr. Watt, at Glafgow, and by Mr. Henry and Mr. Cooper, at Manchefter. Another difficulty prefented itfelf, which had nearly proved fatal to the fuccefs of the operation. This was, the want of a proper apparatus; not for making the acid and combining it with water, for this had been fupplied, in a very ingenious manner, by Mr. Watt and M. Berthollet *; but for the purpofe of immerfing

* M. Berthollet's apparatus, however, is too complex for the ufe of a manufactory. Mr. Watt's is better; but a range of four, five, or fix hogfheads, or rum-puncheons, connected with one another, in the manner of Woulfe's diftilling apparatus, is preferable to either of them. Agitators, on M. Berthollet's principle, may be applied. The retort or matrafs fhould be of lead, ftanding in a water-bath: its neck fhould be of fufficient length to condenfe the common muriatic acid, which always comes over; and it fhould have an inclination towards the body of the retort, fo that the condenfed acid may return into it. I beg leave to obferve here, that I always found the liquor to be ftrongeft, when the diftillation was carried on very flowly. I have alfo found, that the ftrength of the liquor is much increafed

merſing and bleaching goods in the liquor. The volatility of this acid, and its ſuffocating vapours, prevented its application in the way commonly uſed in dye-houſes. Large ciſterns were therefore conſtructed, in which pieces of ſtuff were ſtratified; and the liquor being poured on them, the ciſterns were cloſed with lids. But this method was ſoon found to be defective, as the liquor could not be equally diffuſed; the pieces were, therefore, only partially bleached, being white in ſome parts, and more or leſs coloured in others. Various other contrivances were tried, without ſucceſs, till it was diſcovered that an addition of alkali to the liquor deprived it of its ſuffocating effects, without deſtroying its bleaching powers. The proceſs began then to be carried on in open veſſels, and has been continued in this manner to the preſent period. The bleacher is now able to work his pieces in the liquor, and to expoſe every part of them to its action, without

increaſed by diluting the vitriolic acid more than is uſually done. The following proportions afforded the ſtrongeſt liquor.

Three parts of manganeſe.
Eight parts of common ſalt.
Six parts of oil of vitriol.
Twelve parts of water.

The proportion of manganeſe is ſubject to variation, according to its quality.

inconvenience. This advantage is unqueſtionably great; but it is diminiſhed by the heavy expence of the alkali, which is entirely loſt. It is moreover to be feared, that the alkali which is added to the liquor, though it does not deſtroy its power of bleaching, may diminiſh it; becauſe a ſolution of the oxygenated muriate of potaſh, which differs from the alkaline bleaching liquor in nothing but in the proportion of alkali, will not bleach at all. This is a well known fact, from which we might infer, that the oxygenated muriatic acid will loſe its power of deſtroying the colouring matter of vegetable ſubſtances, in proportion as it becomes neutralized by an alkali. But, as we ſhould not content ourſelves with inferences, however plauſible, when the truth may be eſtabliſhed by experiment, and as I thought the matter of ſufficient importance, I made the following experiments on the ſubject.

I beg leave to premiſe, that in all theſe experiments, I made uſe of one and the ſame acid, which was kept in a bottle with a ground glaſs ſtopper, and ſecured from the influence of light. The manner in which I made the experiments was ſimply this. I weighed, firſt of all, a bottle filled with the colouring ſubſtance which I meant to employ: I then weighed, in a large and perfectly colourleſs bottle, half an ounce of the acid, to which I immediately, but very gradually, added

ſome

ſome of the colouring ſubſtance contained in the former bottle, till the acid ceaſed to deſtroy any more of its colour. The bottle with the colouring ſubſtance was then weighed again, and the difference between its preſent and original weight was noted. The ſame method was obſerved in all the experiments.

Experiment I. To half an ounce of oxygenated muriatic acid, I added a ſolution of indigo in acetous acid *, drop by drop, till the oxygenated acid ceaſed to deſtroy any more colour. It deſtroyed the colour of 160 grains of the acetite of indigo.

Experiment II. A repetition of Experiment I. The colour of 165 grains of acetite of indigo was deſtroyed in this experiment.

Experiment III. A repetition of Experiments I and II. The colour of 160 grains of the acetite was deſtroyed.

* It has been uſual to eſtimate the ſtrength of the oxygenated muriatic acid, by a ſolution of indigo in ſulphuric acid. This method was inadmiſſible in theſe experiments on the comparative ſtrength of the bleaching liquor, with and without alkali; becauſe the ſulphuric acid would have decompoſed the muriate of potaſh, and thereby produced errors. I therefore added to a ſolution of indigo in ſulphuric acid, after it had been diluted with water, acetite of lead, till the ſulphuric acid was precipitated with the lead. The indigo remained diſſolved in the acetous acid.

Experiment IV. To half an ounce of the oxygenated muriatic acid, were added 8 drops of pure potash, in a liquid state. This quantity of alkali was about sufficient to deprive the acid of its noxious odour. This mixture destroyed the colour of 150 grains of the acetite of indigo.

Experiment V. A repetition of Experiment IV. The colour of 145 grains of the acetite was destroyed.

Experiment VI. To half an ounce of the oxygenated muriatic acid, 10 drops of the same alkali were added. It destroyed the colour of 125 grains of the acetite of indigo.

Experiment VII. A mixture of half an ounce of the oxygenated acid, and 15 drops of the alkali, destroyed the colour of 120 grains of the acetite of indigo.

Though I had taken the precaution of avoiding the sulphuric acid, for the reason stated in the foregoing note, I was not quite satisfied with these experiments, on account of errors which might have taken place through a double affinity. I therefore made the following experiments, in which I employed a decoction of cochineal in water, instead of the acetite of indigo.

Experiment VIII. To half an ounce of the oxygenated muriatic acid, a decoction of cochineal was added, till the acid ceased to act on its colour.

It

It deſtroyed the colour of 390 grains of the decoction.

Experiment IX. A repetition of Experiment VIII. The colour of 385 grains of the decoction was deſtroyed in this experiment.

Experiment X. To half an ounce of the acid, 6 drops of the liquid alkali were added. This mixture deſtroyed the colour of 315 grains of the decoction.

Experiment XI. Eight drops of the alkali were mixed with half an ounce of the acid. This mixture deſtroyed the colour of 305 grains of the decoction.

On a comparative view of the reſults of theſe experiments, it will appear, that an addition of potaſh to the bleaching liquor impairs its ſtrength conſiderably. This diminution of power, and the expence of potaſh, are a ſerious loſs in an extenſive manufacture. It would, therefore, be deſirable to have an apparatus for the uſe of the pure oxygenated muriatic acid, ſimply diſſolved in water, which is at once the cheapeſt and beſt vehicle for it. This apparatus muſt be ſimple in its conſtruction, and obtainable at a moderate expence; it muſt confine the liquor, in ſuch a manner as to prevent the eſcape of the oxygenated muriatic acid gas, which is not only a loſs of power, but alſo an inconvenience to the workmen, and dangerous to their health; and it muſt,

at

at the ſame time, be ſo contrived, that every part of the ſtuff which is confined in it, ſhall certainly and neceſſarily be expoſed to the action of the liquor, in regular ſucceſſion. Having invented an apparatus capable of fulfilling all theſe conditions, I have the pleaſure of ſubmitting a deſcription of it to the Society, by means of the annexed drawing.

Explanation of the Figures.

(See Plate XI.)

Fig. 1. is a ſection of the apparatus. It conſiſts of an oblong deal ciſtern, A B C D, made water-tight. A rib, E E, of aſh or beach wood, is firmly fixed to the middle of the bottom C D, being mortiſed into the ends of the ciſtern. This rib is provided with holes, at F F, in which two perpendicular axes are to turn. The lid A B, has a rim G G, which ſinks and fits into the ciſtern. Two tubes H, H, are fixed into the lid, their centres being perpendicularly over the centres of the ſockets F, F, when the lid is upon the ciſtern. At I, is a tube, by which the liquor is introduced into the apparatus. As it is neceſſary that the ſpace within the rim G G be air-tight, its joints to the lid, and the joints of the tubes, muſt be very cloſe; and, if neceſſary, ſecured

cured with pitch. Two perpendicular axes, K, L, made of aſh or beech wood, paſs through the tubes H, H, and reſt in the ſockets F, F. A piece of ſtrong canvas, M, is ſewed very tight round the axis K, one end of it projecting from the axis: the other axis is provided with a ſimilar piece of canvas. N, are pieces of cloth rolled upon the axis L. Two plain pullies O, O, are fixed to the axes, in order to prevent the cloth from ſlipping down. The ſhafts are turned by a moveable handle P. Q, is a moveable pulley, round which paſſes the cord R. This cord, which is faſtened on the oppoſite ſide of the lid, (ſee Fig. 2,) and paſſes over the ſmall pulley S, produces friction, by means of the weight T. By the ſpigot and faucet V, the liquor is let off, when exhauſted.

Fig. 2. A plan of the apparatus, with the lid taken off.

The Manner of using the Apparatus.

The dimenſions of this apparatus are calculated for the purpoſe of bleaching twelve or fifteen pieces of $\frac{4}{4}$ calicoes, or any other ſtuffs of equal breadth and ſubſtance. When the goods are ready for bleaching, the axis L is placed on a frame, in a horizontal poſition, and one of the pieces

pieces N, being faſtened to the canvas M, by means of wooden ſkewers, in the manner repreſented in Fig. 1, is rolled upon the axis, by turning it with the handle P. This operation muſt be performed by two perſons; the one turning the axis, and the other directing the piece, which muſt be rolled on very tight, and very even. When the firſt piece is on the axis, the next piece is faſtened to the end of it by ſkewers, and wound on, in the ſame manner as the firſt. The ſame method is purſued, till all the pieces are wound upon the axis. The end of the laſt piece is then faſtened to the canvas of the axis K. Both axes are afterwards placed in the ciſtern, with their ends in the ſockets F, F, and the lid is put on the ciſtern, by paſſing the axes through the tubes H, H. The handle P is put upon the empty axis, the pulley Q upon the axis on which the cloth is rolled, and the cord R, with the weight T, is put round it, and over the pulley S. The uſe of the friction, produced by this weight, is to make the cloth wind tight upon the other axis. But, as the effect of the weight will increaſe, as one cylinder increaſes and the other leſſens, I recommend that three or four weights be ſuſpended on the cord, which may be taken off gradually, as the perſon who works the machine may find it convenient. As the weights hang in open hooks, which are faſtened to the cord, it will

will be little or no trouble to put them on, and to remove them.

Things being thus diſpoſed, the bleaching liquor is to be transferred from the veſſels in which it has been prepared, into the apparatus, by a moveable tube, paſſing through the tube I, and deſcending to the bottom of the ciſtern. This tube being connected with the veſſels, by means of leaden or wooden pipes, provided with cocks, hardly any vapours will eſcape in the transfer. When the apparatus is filled up to the line *a a*, the moveable tube is to be withdrawn, and the tube I cloſed. As the liquor riſes above the edge of the rim G, and above the tubes H, H, it is evident that no evaporation can take place, except where the rim does not apply cloſely to the ſides of the box: which will, however, form a very trifling ſurface, if the carpenter's work be decently done. The cloth is now to be wound from the axis L, upon the axis K, by turning this; and, when this is accompliſhed, the handle P and pulley Q are to be changed, and the cloth is to be wound back upon the axis L. This operation is, of courſe, to be repeated as often as neceſſary. It is plain, that by this proceſs of winding the cloth from one axis upon the other, every part of it is expoſed, in the moſt complete manner, to the action of the liquor in which it is immerſed. It will be neceſſary to turn, at firſt, very briſkly;

not only becaufe the liquor is then the ftrongeft, but alfo becaufe it requires a number of revolutions, when the axis is bare, to move a certain length of cloth in a given time; though this may be performed by a fingle revolution, when the axis is filled. Experience muft teach how long the goods are to be worked: nor can any rule be given refpecting the quantity and ftrength of the liquor, in order to bleach a certain number of pieces. An intelligent workman will foon attain a fufficient knowledge of thefe points. It is hardly neceffary to obferve, that if the liquor fhould retain any ftrength, after a fet of pieces are bleached with it, it may again be employed for another fet.

With a few alterations, this apparatus might be made applicable to the bleaching of yarn. If, for inftance, the pulley O were removed from the end of the axis K, and fixed immediately under the tube H; if it were perforated in all directions, and tapes or ftrings paffed through the holes, fkains of yarn might be tied to thefe tapes, underneath the pulley, fo as to hang down towards the bottom of the box. The apparatus being afterwards filled with bleaching liquor, and the axis turned, the motion would caufe every thread to be acted upon by the liquor. Several axes might thus be turned in the fame box; and, being connected with each other by pullies, they

they might all be worked by one perſon at the ſame time; as all would turn the ſame way, and with the ſame ſpeed, the ſkains could not poſſibly entangle each other.

In order to ſhew the uſefulneſs of this apparatus ſtill more clearly, I requeſt the Society to attend to the following ſtatement of the expence of a given quantity of bleaching liquor, with and without alkali, but of equal ſtrength.

WITH ALKALI *.

	£.	s.	d.
80 lb. of ſalt, at $1\frac{1}{2}$*d. per* lb. -	0	10	0
60 lb. of oil of vitriol, at $6\frac{1}{2}$ *per* lb.	1	12	6
30 lb. of manganeſe, - -	0	2	6
20 lb. of pearl-aſhes, at 6*d. per* lb.	0	10	0
	£. 2	15	0
But it appears, by the foregoing experiments, that the liquor loſes ſtrength by an addition of alkali. The value of this loſs, which, on an average, amounts to 15 *per cent.* muſt be added to the expence, - - -	0	8	3
	£. 3	3	3

* I make no mention of the expence attending the *preparation* of the liquor, it being the ſame in both caſes.

WITHOUT ALKALI.

	£.	s.	d.
80 lb. of salt, - - -	0	10	0
60 lb. of oil of vitriol, - -	1	12	6
30 lb. of manganese, - -	0	2	6
	£. 2	5	0

It appears from this calculation, that a certain quantity of the liquor, for the use of my apparatus, costs only 2 *l.* 5 *s.* but that the same quantity of the alkaline liquor costs 3 *l.* 3 *s.* 3 *d.* which is 40 *per cent.* more than the other. The aggregate of so considerable a saving must form a large sum, in the extensive manufactures of this country.

XXVIII.

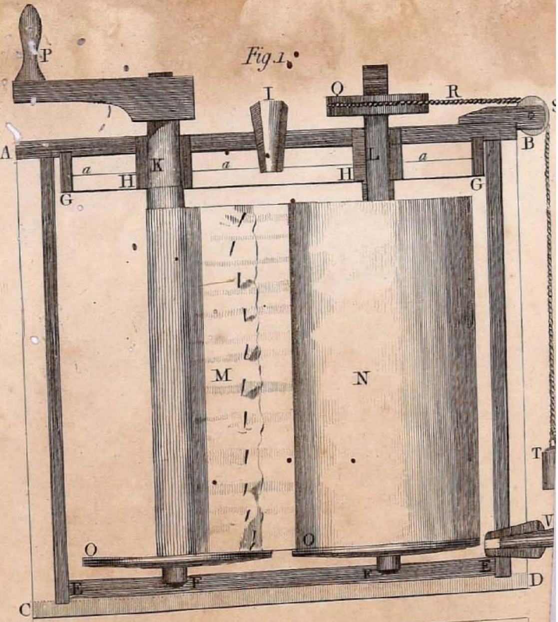


Fig.1.

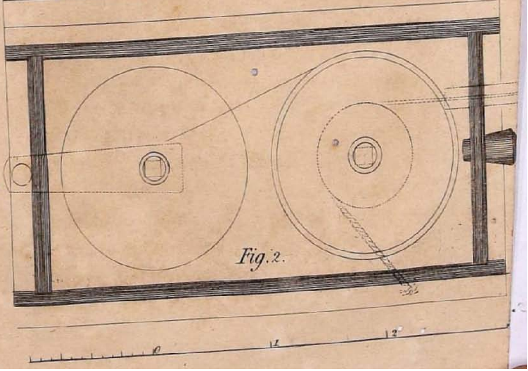


Fig.2.

XXVIII. *Account of the Means employed to obtain an overflowing Well.* By Mr. BENJAMIN VULLIAMY.

WITH A PLATE.

From the PHILOSOPHICAL TRANSACTIONS of the ROYAL SOCIETY of LONDON.

THE well here defcribed was executed entirely under my direction, at Norland Houfe, belonging to Mr. L. Vulliamy. It is a work of great labour and expence, and was finifhed in November, 1794.

Before I began the work, I confidered that it would be of infinite advantage, fhould a fpring be found ftrong enough to rife over the furface of the well; and though I thought it very improbable, yet I refolved to take, from the beginning, the fame precautions in doing the work, as if I had been affured that fuch a fpring would be found. But, although this very laborious undertaking has fucceeded beyond my expectation, yet, from the knowledge I have acquired in the progrefs of the work, I am of opinion that it will very

very ſeldom happen that the water will riſe ſo high; nor will people, I believe, in general, be ſo indefatigable as I have been, in overcoming the various difficulties that did, and ever will occur, in bringing ſuch a work to perfection.

In beginning to ſink this well, which has a diameter of four feet, the land-ſprings were ſtopped out in the uſual manner, and the well was ſunk, and ſteined to the bottom. When the workmen had got to the depth of 236 feet, the water was judged to be not very far off, and it was not thought ſafe to ſink any deeper. A double thickneſs of ſteining was made about 6 feet from the bottom upwards, and a borer of 5½ inches diameter was made uſe of. A copper pipe, of the ſame diameter with the borer, was driven down the bore-hole, to the depth of 24 feet; at which depth, the borer pierced through the rock into the water, and, by the manner of its going through, it muſt probably have broken into a ſtratum containing water and ſand. At the time the borer burſt through, the top of the copper pipe was about 3 feet above the bottom of the well: a mixture of ſand and water inſtantly ruſhed in, through the aperture of the pipe. This happened about two o'clock in the afternoon; and, by twenty minutes paſt three o'clock, the water of the well ſtood within 17 feet of the ſurface. The water roſe the firſt 124 feet, in eleven minutes; and

and the remaining 119 feet, in one hour and nine minutes. The next day, feveral buckets of water were drawn out, fo as to lower the water 4 or 5 feet; and, in a fhort time, the water again rofe within 17 feet of the furface. A founding-line was then let down into the well, in order to try its depth. To our great furprife, the well was not found, by 96 feet, fo deep as it had been meafured before the water was in it; and the lead brought up a fufficient quantity of fand to explain the reafon of this difference, by fhewing that the water had brought along with it 96 feet of fand into the well. Whether the copper pipe remained full of fand or not, is not eafy to be determined; but I fhould rather be inclined to think it did not.

After the well had continued in the fame ftate feveral days, water was drawn out, fo as to lower it 8 or 10 feet; and it did not rife again, by about a foot, fo high as it had rifen before. At fome days interval, water was again drawn out, fo as to lower the water as before; which, at each time of drawing, rofe lefs and lefs, till after fome confiderable time it would rife no more; and the water being then all drawn out, the fand remained perfectly dry and hard. I now began to think the water loft; and, confequently, that all the labour and expence of finking this well, which by this time were pretty confiderable, had

been in vain. There remained no alternative, but to endeavour to recover it, by getting out the ſand, or all that had been done would be uſeleſs; and, although it became a more difficult taſk than ſinking a new well might have been, yet I determined to undertake it, becauſe I knew another well might alſo be liable to be filled with ſand, in the ſame manner that this was. The operation of digging was again neceſſarily reſorted to, and the ſand was drawn up in buckets, until about 60 feet of it were drawn out, and conſequently there remained only 36 feet of ſand in the well. That being too light to keep the water down, in an inſtant it forced again into the well, with the ſame violence it had done before; and the man who was at the bottom, getting out the ſand, was drawn up almoſt ſuffocated, having been covered all over by a mixture of ſand and water. In a ſhort time, the water roſe again within 17 feet of the ſurface, and then ceaſed to riſe, as before. When the water had ceaſed riſing, the ſounding-line was again let down, and the well was found to contain full as much ſand as it did the firſt time of the water's coming into it.

Any farther attempt towards recovering the water now appeared vain; and moſt people would, I believe, have abandoned the undertaking. I again conſidered, that the labour and the expence would be all loſt by ſo doing, and I determined,

determined, without delay, to ſet about drawing the ſand out through the water, by means of an iron box made for that purpoſe, without giving it time to harden as before. The labour attending on this operation was very great; as it was neceſſary continually to draw out the water, for the purpoſe of keeping it conſtantly riſing through the ſand, and thereby to prevent the ſand from hardening. What rendered this operation the more diſcouraging was, that frequently, after having drawn out 6 or 7 feet of ſand in the courſe of the day, upon ſounding the next morning, the ſand was found lowered only 1 foot in the well, ſo that more ſand muſt have come in again. This, however, did not prevent me from proceeding in the ſame manner, during ſeveral days, though with little or no appearance of any advantage ariſing from the great exertions we were making. After perſevering, however, for ſome conſiderable time, we perceived that the water roſe a little nearer to the ſurface, and I began to entertain ſome hopes, that it might perhaps riſe high enough to come above the level of the ground; but, when the water had riſen a few feet higher in the well, ſome difficulties occurred, occaſioned by accidental circumſtances, which very much delayed the progreſs of the work; and it remained, for a conſiderable time, very uncertain whether the water would run over the top of the well or not.

Thefe difficulties being at length furmounted, we continued, during feveral days, the procefs before mentioned, of drawing out the fand and water alternately; and I had the fatisfaction of feeing the water rife higher and higher, until at laft it ran over the top of the well, into a temporary channel that conveyed it into the road. I then flattered myfelf that every difficulty was overcome; but a few days afterwards I difcovered, that the upper part of the well had not been properly conftructed, and it became neceffary to take down about 10 feet of brick-work. The water, which was now a continued ftream, rendered this extremely difficult to execute. I began by conftructing a wooden cylinder, 12 feet long, which was let down into the well, and fufpended to a ftrong wooden ftage above, upon which I had fixed two very large pumps, of fufficient power to take off all the water that the fpring could furnifh, at 11 feet below the furface. The ftage and cylinder were fo contrived as to prevent the poffibility of any thing falling into the well; and I contrived a gage, by which the men upon the ftage could always afcertain, to the greateft exactnefs, the height of the water within the cylinder. This precaution was effentially neceffary, in order to keep the water a foot below the work which was doing on the outfide of the cylinder, to prevent the new work from being

being wetted too ſoon. After every thing was prepared, we were employed eight days, in taking down 20 feet of the wall of the well, remedying the defects, and building it up again; during which time, ten men were employed, five relieving the other five; and the two pumps were kept conſtantly at work, during one hundred and ninety-two hours. By the aſſiſtance of the gage, the water was never ſuffered to riſe upon the new work, until it was made fit to receive it. When the cylinder was taken out, the water again ran over, into the temporary channel that conveyed it into the road.

The top of the well was afterwards raiſed 18 inches, and conſtructed in ſuch a manner as to be able to convey the water five different ways, at pleaſure; with the power of being able to ſet any of theſe pipes dry, at will, in order to repair them, whenever occaſion ſhould require. The water being now entirely at command, I again reſolved upon taking out more ſand, in order to try what additional quantity of water could be obtained thereby. I cannot exactly aſcertain the quantity of ſand taken out, but the increaſe of water obtained was very great; as, inſtead of the well diſcharging thirty gallons in a minute, the water was now increaſed to forty-ſix gallons in the ſame time.

EXPLANATION OF THE FIGURES.

(See Plate XII.)

Fig. 1. *a*, Top of the well, with the water run-ning over.

b b. Ground line.

c. Sand lying in the well.

d. Copper pipe.

f f f f f f. Steining of the well.

g g. Double ſteining, ſix feet from the bottom upwards.

h. Stratum which the end of the copper pipe was driven into.

Figs. 2 and 3. Iron box for drawing ſand out of the well, weighing about 60 lb. one foot ſquare, and two feet nine inches long.

a. Handle of the box.

b. A flap or door, which opens inwards, by a joint at *c*. There is another door, like this, on the other ſide.

c. The joint.

d. The centre or pin of the joint.

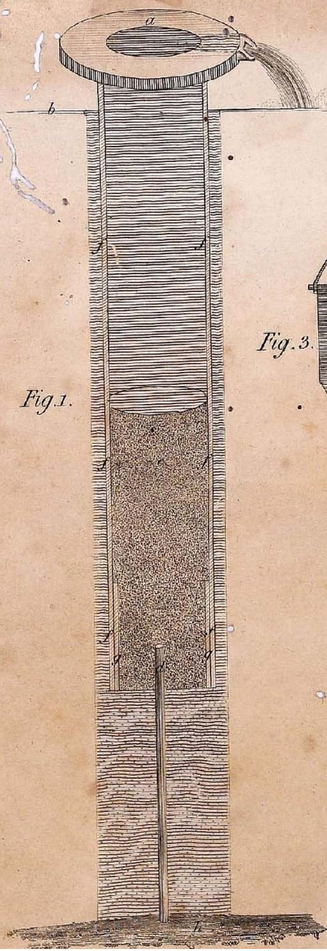


Fig. 1.

Fig. 3.

Fig. 2

XXIX. *An Inquiry concerning the chemical Properties that have been attributed to Light.* By BENJAMIN *Count of* RUMFORD, *F. R. S. M. R. I. A.*

From the PHILOSOPHICAL TRANSACTIONS of the ROYAL SOCIETY of LONDON.

IN the Second Part of my Seventh Eſſay, (on the propagation of heat in fluids,) I have mentioned the reaſons which had induced me to doubt of the exiſtence of thoſe chemical properties in light that have been attributed to it, and to conclude, that all thoſe viſible changes produced in bodies by expoſure to the action of the ſun's rays, are effected, not by any chemical combination of the matter of light with ſuch bodies, but merely by the heat which is generated, or excited, by the light that is abſorbed by them.

As the deciſion of this queſtion is a matter of great importance to the advancement of ſcience, and particularly to chemiſtry, and as the ſubject is in many reſpects curious and intereſting, it has often

often employed my thoughts in my leiſure hours; and I have ſpent much time in endeavouring to contrive experiments, from the unequivocal reſults of which the truth might be made to appear. Though I have not been ſo ſucceſsful in theſe inveſtigations as I could wiſh, yet I cannot help flattering myſelf, that an account of the reſults of ſome of my late experiments will be thought ſufficiently intereſting to merit the attention of the Royal Society.

Having found that gold, or ſilver, might be melted by the heat (inviſible to the ſight) which exiſts in the air, at the diſtance of more than an inch above the point of the flame of a wax-candle, (ſee my Seventh Eſſay, Part II. page 350.) I was curious to know what effect this heat would produce on the oxides of thoſe metals.

Experiment No. 1. Having evaporated to dryneſs a ſolution of fine gold in aqua regia, I diſſolved the reſiduum, in juſt as much diſtilled water as was neceſſary in order that the ſolution (which was of a beautiful yellow colour) might not be diſpoſed to cryſtallize; and, wetting the middle of a piece of white taffeta riband, 1½ inch wide, and about eight inches long, in this ſolution, I held the riband, with both my hands, ſtretched horizontally over the clear bright flame of a wax-candle; the under ſide of the riband being kept at the diſtance of about 1½ inch above the

the point of the flame. The reſult of this experiment was very ſtriking. That part of the riband which was directly over the point of the flame, began almoſt immediately to emit ſteam in denſe clouds; and, in about ten ſeconds, a circular ſpot, about three-fourths of an inch in diameter, having become nearly dry, a ſpot of a very fine purple colour, approaching to crimſon, ſuddenly made its appearance in the middle of it, and, ſpreading rapidly on all ſides, became, in one or two ſeconds more, nearly an inch in diameter.

By moving the riband, ſo as to bring, in their turns, all the parts of it which had been wetted with the ſolution to be expoſed to the action of the current of hot vapour that aroſe from the burning candle, all thoſe parts which had been ſo wetted, were tinged with the ſame beautiful purple colour.

This colour, which was uncommonly brilliant, paſſed quite through the riband, and I found the ſtain to be perfectly indelible. I endeavoured to waſh it out; but nothing I applied to it, and among other things I tried ſuper-oxygenated marine acid, appeared in the ſmalleſt degree to diminiſh its luſtre. The hue was not uniform, but varied from a light crimſon to a very deep purple, approaching to a reddiſh brown.

I ſearched,

I ſearched, but in vain, for traces of revived gold, in its reguline form and colour; but, though I could not perceive that the riband was gilded, it had all the appearance of being covered with a thin coating of the moſt beautiful purple enamel, which, in the ſun, had a degree of brilliancy that was ſometimes quite dazzling.

Experiment No. 2. A piece of the riband which had been wetted with the aqueous ſolution of the oxide, was carefully dried in a dark cloſet, and was then expoſed, dry, over the flame of a burning wax-candle. The part of the riband which had been wetted with the ſolution, (and which on drying had acquired a faint yellow colour,) was tinged of the ſame bright purple colour as was produced in the laſt-mentioned experiment, when the riband was expoſed wet to the action of the heat *.

Experiment No. 3. A piece of the riband which had been wetted with the ſolution, and dried in the dark, was now wetted with diſtilled water, and expoſed wet to the action of the aſcending current of hot vapour which aroſe from the burning candle: the purple ſtain was produced

* We ſhall hereafter find reaſon to conclude, that the ſucceſs of this experiment, or the appearance of the purple tinge, was owing to the watery vapour which exiſted in the hot current that aſcended from the flame of the candle.

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as before, which extended as far as the riband had been wetted with the ſolution, but no farther.

I afterwards varied this experiment in ſeveral ways, ſometimes uſing paper, ſometimes fine linen, and ſometimes fine cotton cloths, inſtead of the ſilk riband; but nearly the ſame tinge was produced, whatever the ſubſtance was that was made to imbibe the aqueous ſolution of the metallic oxide.

Similar experiments, and with ſimilar reſults, were likewiſe made with pieces of riband, fine linen, cotton, paper, &c. wetted in an aqueous ſolution of nitrate of ſilver; with this difference, however, that the tinge produced by this metallic oxide, inſtead of being of a deep purple, inclining to crimſon, was of a very dark orange colour, or rather of a yellowiſh brown.

In order to diſcover whether the purple tinge, in the experiments with the oxide of gold, was occaſioned by the *heat* communicated by the aſcending current of hot vapour, or by the *light* of the candle, I made the following experiment; the reſult of which, I conceive to have been deciſive.

Experiment No. 4. A piece of riband was wetted with the aqueous ſolution of the oxide of gold, and held vertically by the ſide of the clear flame of

of a burning wax-candle, at the diſtance of leſs than half an inch from the flame.

The riband was dried, but its colour was not in the ſmalleſt degree changed.

When it was held a few ſeconds within about one-eighth of an inch of the flame, a tinge of a moſt beautiful crimſon colour, in the form of a narrow vertical ſtripe, was produced.

The heat which exiſted at that diſtance from the flame, *on the ſide of it*, where this coloured ſtripe was produced, was ſufficiently intenſe, as I found by experiment, to melt very fine ſilver wire, flatted, ſuch as is uſed in making ſilver lace.

The objects I had in view in the following experiments, are too evident to require any particular explanation.

Experiment No. 5. Two like pieces of riband were wetted at the ſame time in the ſolution, and ſuſpended, while wet, in two thin phials, A and B, of very tranſparent and colourleſs glaſs; the mouths of the phials being left open. Both theſe phials were placed in a window which fronted the ſouth; that diſtinguiſhed by the letter A being expoſed naked to the direct rays of a bright ſun; while B was incloſed in a cylinder of paſteboard, painted black within and without, and cloſed with a fit cover, and conſequently remained in perfect darkneſs.

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In a very few minutes, the riband in the phial A began fenfibly to change its colour, and to take a purple hue; and, at the end of five hours, it had acquired a deep crimfon tint throughout.

The phial B was expofed in the window, in its dark cylindrical cover, three days; but there was not the fmalleft appearance of any change of colour in the filk.

Experiment No. 6. Two fmall parcels of *magnefia alba*, in an impalpable powder, (about half as much in each as could be made to lie on a fhilling,) were placed in heaps, in two China plates, A and B, and thoroughly moiftened with the fore-mentioned aqueous folution of the oxide of gold. Both plates were placed in the fame window: the moiftened earth in the plate A being expofed naked to the fun's rays; while that in the plate B was exactly covered with a tea-cup, turned upfide down, which excluded all light.

The *magnefia alba* in the plate A, which was expofed to the ftrong light of the fun, began almoft immediately to change colour, taking a faint violet hue, which by degrees became more and more intenfe, and in a few hours ended in a deep purple; while that in the plate B, which was kept in the dark, retained the yellowifh caft it

it had acquired from the ſolution, without the ſmalleſt appearance of change.

Experiment No. 7. A ſmall parcel of *magneſia alba*, placed on a China plate, having been moiſtened with the aqueous ſolution of the oxide of gold, and thoroughly dried in a dark cloſet, was now expoſed, *in this dry ſtate*, to the action of the direct rays of a very bright ſun.

It had been expoſed to this ſtrong light above half an hour, before its colour began to be *ſenſibly changed*; and, at the end of three hours, it had acquired only a very faint violet hue.

Being now thoroughly wetted with diſtilled water, it changed colour very rapidly, and ſoon came to be of a deep purple tint, approaching to crimſon.

Experiment No. 8. A piece of white taffeta riband, which had been wetted with the ſolution, and thoroughly dried in the dark, was ſuſpended in a clean dry phial of very fine tranſparent glaſs; and the phial, being well ſtopped with a dry cork, was expoſed to the ſtrong light of a bright ſun.

After the riband had been expoſed, in this manner, to the action of the ſun's direct rays about half an hour, there were here and there ſome faint appearances of a change of its colour; but it ſhowed no diſpoſition to take that deep purple

purple hue which the riband had always acquired, when expofed to the light in the preceding experiments.

On taking the riband out of the phial, and wetting it thoroughly with diftilled water, and expofing it again, *while thus wetted*, to the fun's rays, it almoft inftantly began to change colour, and foon became of a deep purple tint; but, though I examined the furface of the riband with the utmoft care, and with a good lens, both during the experiment and after it, I could not perceive the fmalleft particle of *revived gold*, nor did I fee any veftige remaining that appeared to indicate that any had in fact been revived.

This experiment was repeated feveral times, and always with refults which led me to conclude, (what indeed was reafonable to expect,) that light has little effect in changing the colour of metallic oxides, *as long as they are in a ftate of cryftallization.*

The heat which is generated by the abforption of the rays of light, muft neceffarily, *at the moment of its generation* at leaft, exift in almoft infinitely fmall fpaces; and confequently, it is only in bodies that are *inconceivably fmall* that it can produce durable effects, in any degree indicative of its extreme intenfity:

Perhaps

Perhaps the particles of the oxide of gold diſſolved in water are of ſuch dimenſions; and it is very remarkable, that the colours produced, in ſome of my experiments on white ribands, by means of an aqueous ſolution of the oxide of gold, are preciſely the ſame as are produced from the oxide of that metal, by enamellers, in the intenſe heat of their furnaces.

As the colouring ſubſtance is the ſame, and as the colours produced are the ſame, why ſhould we not conclude that the effects are produced in both theſe caſes by the ſame means, that is to ſay, by the agency of heat? or, in other words, and to be more explicit, by expoſing the oxide in a certain temperature, at which it becomes diſpoſed to vitrify, or to undergo a change in regard to the quantity of oxygen with which it is combined?

But the reſults of the following experiments afford ſtill more ſatisfactory information, reſpecting the intenſity of the heat generated in all caſes where light is abſorbed, and the ſtriking effects which, under certain circumſtances, it is capable of producing.

The facility with which moſt of the metallic oxides are reduced, in the dry way, by means of charcoal, ſhows that, at a certain (high) temperature, oxygen is diſpoſed to quit thoſe metals,

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in order to form a chemical union with the charcoal, or at leaſt with ſome one of its conſtituent principles, if it be a compound ſubſtance; and hence I concluded, that gold might be revived, *in the moiſt way*, by means of charcoal, from a ſolution of its oxide in water, were it poſſible, under ſuch circumſtances, to communicate to the charcoal, and to the oxide, *at the ſame time*, a degree of heat ſufficient for that purpoſe.

To ſee if this might not be done by means of light, I made, or rather repeated, the following very intereſting experiment.

TO BE CONCLUDED IN OUR NEXT.

XXX.

XXX. *Conclufion of Meffrs.* Deyeux, Molard, Pelletier, *and* Verkaven's *Inftructions refpecting the Manner of making Paper afrefh, from Leaves of Books, &c.*

(From Page 142.)

Preparation of the cauftic Ley.

1. PUT a hundred pounds of dry potafh, of a good quality, into a wooden tub; and pour upon it three hundred quarts of boiling water.

The tub fhould have feveral openings, for drawing off the liquor; the loweft of which fhould be made about eight inches from the bottom, the fecond four or five inches above that, and fo on.

2. Let the potafh be diffolved in the water, by ftirring it with long fticks, and then add twenty pounds of very good quick-lime, broken into fmall pieces; ftir the whole well together, until the lime is completely flaked, and the mixture has acquired an uniform and fmooth confiftence; after which, cover the tub, and leave the matter at reft.

3. At

3. At the end of twelve hours, the clear liquor may be drawn off; first, through the highest opening, then through the second, &c. If the liquor which runs through the last opening should be turbid, it must be kept apart from the rest. The clear liquor is to be put into earthen bottles, well stopped.

4. To the matter remaining in the tub, after the clear liquor just spoken of is drawn off, is to be added, one-fourth part as much water as was at first poured on: the mixture must be stirred for half an hour, then left to settle till it is clear; the liquor is afterwards to be drawn off, and mixed with that already prepared.

5. Water is then to be poured, a third time, upon the matter remaining in the tub; but, as this third ley will be very weak, it must not be mixed with the others, but must be kept, to be used, instead of water, in any subsequent operation.

6. A caustic ley, similar to that here described, may be prepared with barilla, instead of potash; in the preparation of which, the proportions of water, and of lime, are to be the same as when potash is employed; and the whole process is to be conducted in the manner above directed.

Proceſs for the Re-fabrication of written Paper.

1. The paper written on muſt be ſorted, ſo as to collect together all paper of the ſame ſhade of colour.

2. All ſeals, ſtamps, and other foreign ſubſtances mixed with it, of whatever nature, muſt be taken away.

3. All paper that is of a very yellow colour muſt be laid aſide; experience having ſhewn, that this ſort of paper does not ſerve for the purpoſe here treated of, ſo well as paper which is not of that colour.

The ſame muſt be done with that upon which there are any printed letters, or any ſpots of greaſe.

4. The edges of leaves which are become very yellow, or upon which there is any colour, muſt alſo be taken away. The inſtrument uſed by the bookbinders, for cutting the leaves of books, may be advantageouſly employed for this purpoſe.

5. Theſe precautions having been taken, the paper is to be thrown, leaf by leaf, into a tub half-full of boiling water; and it muſt be ſtirred with long wooden paddles, in the manner already directed with reſpect to printed paper.

6. When

6. When it has macerated for the ſpace of four hours, the water may be drawn off, through the orifice in the tub.

7. A freſh quantity of hot water is then to be added, and the mixture is to be ſtirred for half an hour; after which, the paper may again be left to macerate for three hours.

8. The orifice of the tub muſt then be once more opened, and the liquor again drawn off, preſſing the paper gently with the paddles, to facilitate the diſcharge of the water.

9. Water is then to be poured, for the third time, on the paper in the tub; but the water, this time, muſt be cold; and the quantity poured on muſt be in the proportion of two hundred and ſixty quarts, to one hundred pounds of paper.

10. After having well mixed the paper with the above-mentioned quantity of cold water, ſix pounds of oil of vitriol (of 66 degrees by the areometer) are to be added gradually. Before the oil of vitriol is poured in, it ſhould be mixed with twice its weight of boiling water.

It muſt be remarked, that this mixture of oil of vitriol with water can only be made little by little, and in veſſels of glaſs, or (which is ſtill better) of earthen-ware.

11. While the acid liquor (prepared as above directed) is poured into the tub, the mixture is to be ſtrongly ſtirred; which ſtirring ſhould be

 continued

continued for a confiderable time, that all the paper may be thoroughly impregnated with the liquor.

12. The whole is then to be left to macerate for the fpace of at leaft twelve hours, taking care to ftir it from time to time.

13. At the end of that time, the tub is to be filled up with cold water; the mixture is to be again ftirred, in order to wafh the paper, which, by this time, will be reduced into a pafte; after which, the orifice of the tub may be opened, and the water fuffered to run off.

14. When all the water has drained off, the pafte is to be again mixed with cold water, and to be ftirred for half an hour; after which, it is to be taken out, by means of the ladles before defcribed, and put into open wicker-bafkets.

15. When the pafte, by having been fome time in the bafkets, is become fufficiently dry, it is to be put into bags, and fubmitted to the action of a ftrong prefs.

16. The matter remaining after being preffed, is to be put under the roller, and ground for the fpace of an hour, more or lefs, according to the ftate of divifion in which it fhall appear to be.

17. This operation being finifhed, the pafte is to be carried to the vat of the workmen who are to make it into paper.

18. Laftly,

18. Lastly, the paper obtained by any of the proceſſes above deſcribed is to be ſized, and finiſhed in the ſame manner as that which is prepared in the common way.

Deſcription of a Machine, propoſed to be made, for the Purpoſe of grinding the Paſte prepared from old Paper, while it is yet wet with the alkaline Liquor.

The object of the machine here propoſed is, to grind the forementioned paſte in the very ley which ſerves to take the ink from it, in order that the diſſolution of the ink may be more complete, and the paſte more eaſily and quickly waſhed; conſequently, it may admit of ſome variation in its conſtruction, according to the intention and fancy of the artiſts who mean to uſe it for the re-fabrication of old paper.

The machine we propoſe for the above purpoſe is to conſiſt principally of a wooden trough, about eight feet long, and eighteen or twenty inches wide within; with a wooden roller, the diameter of which is to be from thirty to thirty-ſix inches, and its thickneſs nearly equal to the width of the bottom of the trough.

This roller is to be made up of a number of flat pieces of wood, fixed upon an axis, and kept

kept together by ſeveral iron pins paſſing through them.

Theſe round pieces of wood are to be fixed upon the axis, in ſuch a manner, that their edges ſhall form the circumference of the roller; which edges ſhall have notches cut in them, that the roller may have more effect upon the paſte, when made to move backward and forward, from one end of the trough to the other. Motion is to be given to the roller, by means of a piece of wood, placed horizontally upon it, and kept in its place by two iron ſupports, fixed on each end of the trough. This piece of wood is to have a ſlip faſtened to each ſide of it, to confine the roller, at the ſame time that it acts upon it by its weight, and makes it turn round. The edges of the trough ſhould be a little turned out, and they ſhould be ſufficiently high to keep in the paſte.

It is preſumed, that the machine here propoſed, the conſtruction of which is very ſimple, and by no means expenſive, will anſwer the purpoſe for which it is intended, namely, to bruiſe the paſte, and to divide the ink, in ſuch a manner, that no traces of it ſhall remain, except ſmall black points, which may be eaſily taken away by waſhing.

XXXI. *On the Uſe of fine Wire-work or metallic Gauze, as a Subſtitute for Horn, in making Lanterns for the Navy.* By ALEXIS ROCHON, *Director of the Marine Obſervatory at Breſt.*

FROM THE *JOURNAL DE PHYSIQUE.*

IN conſequence of the war with England, the naval magazines of France became entirely deſtitute of horn fit for making the large lanterns placed at the ſtern of ſhips; yet it was impoſſible to do without them, or without other lanterns, which are neceſſary in various parts of the ſhip, particularly during engagements. The great brittleneſs of glaſs was a ſufficient obſtacle to the uſe of that ſubſtance, in the place of horn; on account of the danger that would attend the breaking of ſuch a lantern in the powder-room, or in any other part of the ſhip, where powder, or other combuſtible matter, might happen to be.

In this ſtate of diſtreſs I was conſulted; and the agents of government deſired me, without delay,

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to conſider what could be done by way of remedy. The voyages I had made to India, and my intimacy with M. Poivre, had procured me ſome knowledge reſpecting the arts of the Indians and Chineſe. In looking over my notes, I found one written by that eminent man, reſpecting the fabrication of the Chineſe horn lanterns. It is well known that this induſtrious nation make great uſe of lanterns in their houſes, and they prefer horn to glaſs, becauſe it is lighter, cheaper, and leſs brittle: they alſo poſſeſs the art of joining it ſo perfectly, that they make lanterns of two feet diameter, which appear to be of one entire piece. Theſe large horn lanterns are ſurpriſingly tranſparent, and much ſuperior to thoſe made in any other place. It is, however, very certain, that the Chineſe make uſe of the horns of goats and ſheep only, which they ſoften in boiling water, and then, after having taken away the bony part, flatten them. But this laſt operation is preceded by another of the ſame kind: they not only expoſe the horn to the penetrating vapour of boiling water, but they alſo ſeparate it into laminæ. Theſe laminæ, in the horn, are concentric; and, by their number, an anatomiſt can gueſs at the age of the animal. In the above operation a difficulty occurs, which I know not how the Chineſe get over. When horns receive blows

blows or bruiſes, a kind of callus or knot is formed, which muſt neceſſarily impede the ſeparation of theſe laminæ; but that which ſeems a great difficulty, is not always one for theſe artiſts, who, to wonderful ſkill, join indefatigable patience.

Inſtead of ſeparating the laminæ in the manner above mentioned, they may be ſeparated by ſawing, and then ſcraped and poliſhed; by which means it is eaſy, if the horns of cows and oxen be uſed, inſtead of thoſe of goats and ſheep, to procure horn fit for making lanterns in every country; but I believe it is better to ſeparate the laminæ by boiling water, than by the ſaw.

While I was employed in eſtabliſhing a manufactory of this kind at Breſt, and endeavoured, by the help of cauſtic alkali, to reduce the horns of cows and oxen into a kind of paſte, in order to laminate them, (for which purpoſe I employed a kind of Papin's digeſter, which had been procured for the purpoſe of making portable ſoup for the navy,) it ſuddenly occurred to me, that I might fulfil the purpoſe I had in view, by a proceſs which was entirely new, and could be more ſpeedily completed. I therefore poſtponed, to another opportunity, my experiments on the fabrication of horn lanterns; for, however quickly ſuch lanterns might have

have been made by the procefs of laminating, they could not have been finifhed in time to fupply the urgent wants of the navy. This led me to fuppofe, that the wire-gauze which has been long ufed in England, for making fieves, might fulfil, to a certain point, the ends I had in view, provided it were coated with a fubftance that was tranfparent, and impervious to the air.

My firft expedient, to preferve from ruft the iron wire of which the gauze was made, was to give it a coating of tin; an operation which, on feveral accounts, is very difficult. I have fince found it better to give the gauze a flight coating of oil paint; a method which is in every refpect preferable to the former. When the gauze has been tinned, or painted, it is to be plunged into a tub filled with melted glue, very pure and tranfparent; the heat of which fhould not be too great, nor its confiftence too thick; but, in thefe refpects, the workman can only be guided by experience. The high price of ifinglafs induced me to prepare my glue from the cuttings of parchment, and from the air bladders and membranes of fea-fifh.

Garlick juice and cyder give a great degree of tenacity to the coating, which alfo appears to acquire rather more tranfparency by the ufe of thefe fluids.

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When the lanterns are made, the outſide of the coating muſt be defended from moiſture; for which purpoſe, pure drying linſeed oil may be advantageouſly employed. Nothing can be more eaſily repaired, in caſe of accident, than theſe lanterns; all that is neceſſary, in that caſe, being a coating of glue: but they ſhould be only uſed within the ſhip, and it is very wrong to uſe them on the outſide, particularly as ſignal lanterns. It has, however, been found neceſſary to uſe them for that purpoſe, and I was much ſurpriſed to ſee theſe new and uſeful machines applied to purpoſes that might tend to bring them into diſcredit; on which account, when the expedition failed to Ireland, I cauſed the ſignal lanterns of the frigate which carried the admiral and the general, to be made of mica or Muſcovy talc. This kind of mica is brought in large plates from the neighbourhood of Boſton; conſequently it may be eaſily procured by means of American ſhips. The laminæ of mica, when uſed for making lanterns, ſhould be encloſed between two pieces of very open wire-work.

I have ſince made, with the above ſubſtance, ſome large ſquares, twenty-ſix inches high, and eighteen inches wide, to replace, in the lighthouſe of the iſland of Uſhant, ſome ſquares of glaſs, of the above dimenſions, which had been

 broken

broken by a flight of wild ducks: theſe birds not only broke the glaſs, but alſo extinguiſhed the lights. This accident, which happily is not a common one, ſhews the neceſſity of defending the windows of light-houſes by ſurrounding them with wire-work.

I muſt obſerve, that theſe wire-gauze lanterns are much cheaper than thoſe made with horn: there is a ſaving of tin; they are repaired with little expence, and they give a ſtronger light.

I alſo made a trial of very open painted wire-work, for another purpoſe, to which it may perhaps, in future, be advantageouſly applied. I covered one of my workſhops with this wire-work, coated with a thin layer of plaſter, in order to preſerve it from fire: but I think it probable that a cement, compoſed of lime and ſcales of iron, beat into powder, would have been preferable. This covering ought not to be thicker than a ſlate; and ſhould be penetrated with boiling fiſh oil, and then painted over with tar and ochre, in the manner practiſed with reſpect to gun-carriages. By theſe means, a roof may be obtained, which is little acted on by the wind, and which, when the manner of making it is brought to perfection, may ſerve for ſuch ſheds, or other buildings, as it is particularly neceſſary to defend from fire.

In trying to diſcover a fit varniſh to protect my new kind of lanterns from moiſture, I did not make uſe of copal, or any other reſin, as the varniſh made with them is always more or leſs brittle; but employed a perfect ſolution of the elaſtic gum, in drying linſeed oil. This varniſh (if it may be ſo called) attracting the attention of M. Genouin, principal apothecary to the marine hoſpital at Breſt, he aſked me, whether it might not be poſſible to uſe it in making bougies, &c. which, at that time, were much wanted in the hoſpitals.

Being in poſſeſſion of one of the machines uſed in England for weaving whips, I thought I ſhould, with its aſſiſtance, be able to make bougies, &c. ſimilar to thoſe invented by M. Bernard; but I ſoon found that the twiſted cord required ſome preparation before it was varniſhed. This preparation conſiſts in plunging it into melted wax, in which a little ochre, or other ſuch ſubſtance, is mixed. Afterwards I draw it through a hole made in a plate of metal, to take off the ſuperfluous wax, and render its ſurface perfectly ſmooth: it is then fit to receive the varniſh of elaſtic gum. Bougies made in this manner, are equal, if not ſuperior, to thoſe brought from Paris; and I am happy in having this opportunity of publiſhing the above method of making them,

them, as they are inſtruments of great importance, to thoſe who are ſo unfortunate as to labour under diſorders which require them.

In making my lanterns, I was aſſiſted by Sartori, a painter of Breſt, who found that iſinglaſs was preferable to parchment glue for open wire-work, becauſe it had a better conſiſtence, and was more tranſparent.

We have ſeen another printed account of this diſcovery, in which it is ſaid, that moſt of the lanterns at preſent uſed in the maritime arſenals of France, are made according to the proceſs deſcribed in the foregoing paper.

XXXII.

XXXII. *Liſt of Patents for Inventions, &c.*

(Continued from Page 144.)

Thomas Turner, of Greville-ſtreet, in the pariſh of Saint Andrew, Holborn, in the county of Middleſex, Ironmonger; for improvements in the conſtruction or making of locks. Dated December 8, 1798.

John Marks, of Tabernacle-row, Finſbury-ſquare, in the county of Middleſex, Taylor; for a method of making gentlemen's breeches, ſo as entirely to do away all the inconveniences hitherto complained of. Dated December 8, 1798.

William Raley, of Newbald, in the Eaſt-Riding of Yorkſhire, Chemiſt; for a philoſophical furnace and boiler, with an [illegible] wheel, being an appendage to the ſaid philoſophical furnace and boiler, &c. Dated December 8, 1798.

Joshua Collier, of Weſt-ſquare, in the pariſh of Saint George, in the county of Surrey; for

for a chemical proceſs for freeing fiſh-oils from their impurities, in point of ſmell, taſte, and colour; and for improved ſtrainers for oils, and other liquids; with other inſtruments, for aſcertaining their qualities, and aſſiſting their burning. Dated December 12, 1798.

William Hart, of the pariſh of Saint James, Weſtminſter, in the county of Middleſex, Brazier; for improved methods of raiſing beer, ale, ſpirituous liquors, &c. from the cellar to the bar, or any other part of the houſe, for the uſe of publicans, brewers, diſtillers, and others. Dated December 17, 1798.

John Randall Peckham, of the pariſh of Saint Mary Magdalen, Bermondſey, in the county of Surrey, Watch-maker; for a method of conſtructing a watch, ſo as to unite it with a mariner's compaſs, in ſuch a manner as to anſwer every purpoſe (with equal accuracy and perfection) for which either of them may be ſeparately uſed; which he calls a *Polar Watch*. Dated December 17, 1798.

REPERTORY

OF

ARTS AND MANUFACTURES.

NUMBER LVIII.

Printed by NICHOLS and SON, Red-Lion-Paſſage, Fleet-Street, London.

XXXIII. *Specification of the Patent granted to Mr.* ANDREW MEIKLE, *of Knowſmill, in the Pariſh of White-kirk, in the County of Eaſt Lothian, North Britain, Engineer and Machiniſt; for his Invention of a Mill or Machine for ſeparating Corn of all Kinds from the Straw; which Machine is capable of being worked either by Cattle, Wind, Water, or any other Power, whereby the Corn may be ſeparated in a leſs Time, and in a more effectual Manner, than by thraſhing.*

WITH A PLATE.

Dated April 9, 1788.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE, that I the ſaid Andrew Meikle, in

in compliance with the ſaid proviſo, do hereby aſcertain and deſcribe the nature and manner of my ſaid invention, in manner following that is to ſay:

The ſeveral drawings hereunto delineated, marked Figs. 1, 2, 3, 4, 5,* (ſee Plate XIII.) are ſo many ſections or repreſentations, in which are diſplayed the nature and uſe of the machinery, in my method of ſeparating corn from the ſtraw; the particulars of which the machine and invention conſiſt being as follows.

A, A, A, are wheels for working the machine.

B, is the lying-ſhaft, upon which the machine is fixed.

C, is the machine upon which the ſcutchers are fixed.

D, is the breaſt, moveable backwards and forwards upon a centre, to keep the corn cloſe to the ſcutchers.

E. A weight over a pulley, to keep the breaſt cloſe up to the ſcutchers: this may be alſo done by a weight upon the end of a lever.

F. A weight over a pulley, to keep one of the rollers that feeds in the corn cloſe up to the ſcutchers.

* The ſame letters refer to the ſame parts, in all the figures.

G. Levers to which weights are hung, to press down the upper roller that feeds in the corn, so as to press the straw close together, for scutching.

H. Two fluted rollers, for feeding in the corn, pressed down by weights and levers, so as to keep a firm hold of the corn, as it is feeding.

I, I. Wheels for driving the rollers for feeding in the corn, and may be varied in a different position.

K. Two small wheels, for driving both the feeding rollers.

L. Iron work for moving a harp.

M. Harp for separating the straw from the corn.

N. A board for spreading the corn on, where it is fed by the two rollers, to be scutched.

Fig. 1, is an elevation of the whole machine, calculated for being worked by cattle.

Fig. 2, is a section, exhibiting the right hand side of the machine.

Fig. 3, is a section, exhibiting the left hand side of the same.

Fig. 4, is an end-view of the scutchers, breast, and rollers.

Fig. 5, is a side-view of the scutchers.

These several parts work and operate by any power, such as that of cattle, wind, or water,

 and

and produce the effect of the ſeparation of corn from ſtraw, in manner following, *viz.*

When the mill is ſet a-going, the ſheaf of corn is taken up, and ſpread upon the board marked N; where the two fluted rollers, marked H, take hold of it, and feed it on gradually, ſo that the ſcutchers, marked C, coming round, ſcutch the corn off from the ſtraw; and the breaſt, marked D, moveable upon a centre below, moves backward and forward, when the corn is put in thick or thin.

When the corn comes from the ſcutchers, it falls into the harp, marked M, by which the corn is ſeparated from the ſtraw: below the harp a pair of fawners may be placed, ſo as to ſeparate the corn from the chaff. In witneſs whereof, &c.

Fig. 1.

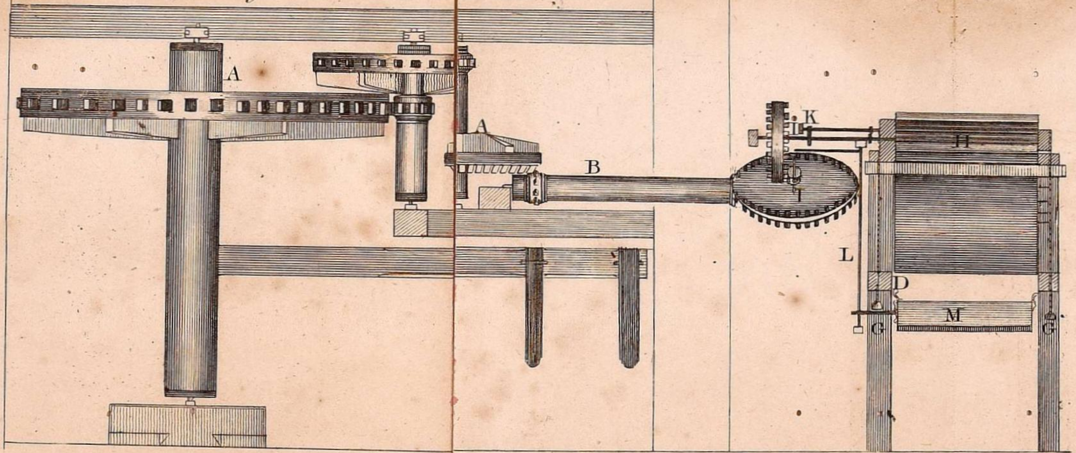


Fig. 5.

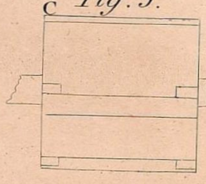


Fig. 4.

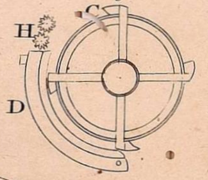


Fig. 2.

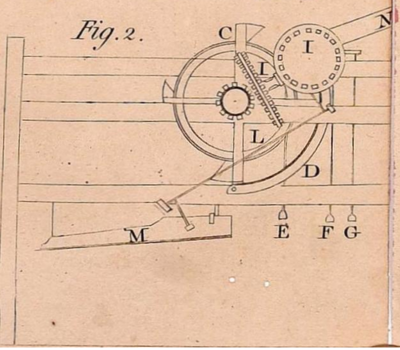
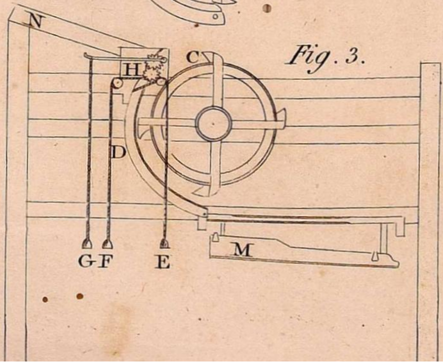


Fig. 3.



XXXIV. *Specification of the Patent granted to* SAMUEL BENTHAM, *of Queen-Square-Place, Weſtminſter, in the County of Middleſex, Eſquire; for his Invention of various new and improved Methods and Means of working Wood, Metal, and other Materials.*

Dated April 23, 1793.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE, that in compliance with the ſaid proviſo, I the ſaid Samuel Bentham do hereby declare, that my ſaid invention is deſcribed in manner following; that is to ſay:

I. *Formation of laminated work from ſhavings.* Boards, when reduced to a certain thickneſs, which is different, according to the nature of the wood, eaſily break in the direction of the grain: take two or more ſtrata, cement them one on the other, (the grain of one croſſing that of the other, or of the two others to which it is contiguous,) and the ſtrength of the whole, as is well known to workmen in wood, is very much increaſed. In this way, out of no more than three, or even two ſhavings, I make a new kind of paſteboards, which

which are applicable, with advantage, to a variety of purpoſes. That the grain of the wood may receive as little injury in its texture as poſſible, in the operation of making the ſhaving, the plane I uſe for the purpoſe is one in which the iron is much more inclined than ordinary; in ſome inſtances, ſo much ſo as to be more like a ſpoke-ſhave, or a cucumber ſlicer, than what is commonly meant by a plane; inaſmuch as nothing but the cutting iron is made to paſs between the ſhaving and the wood from whence the ſhaving is cut. Another precaution, taken with the ſame view, is to wet the wood well, juſt before the ſhaving is taken off: this may be done with cold water, but ſtill better with hot water, or ſteam. (For the method of making a plane capable of taking ſhavings for this purpoſe, to any breadth, ſee the ſpecification of the patent lately granted to me for my new mode of planing *.) For ſtrength in proportion to weight, the great object to accompliſh is, that a diſconnecting force, in whatever direction applied, ſhall in that direction find the texture of the ſubſtance, whether in reſpect of natural or artificial configuration, ſuch as ſhall enable it to oppoſe the greateſt degree of reſiſtance. On theſe principles, not only boards, but tubes of wood, and other materials, may be compoſed of a hitherto

* This ſpecification is given in our fifth volume, p. 293.

unpre-

unprecedented degree of lightneſs in proportion to ſtrength, or ſtrength in proportion to lightneſs, according as the one or the other quality is principally in view. This may be done by winding a ſingle veneer or ſhaving, ſpiral-wiſe, lightly round a mandril; the edge of each ſucceeding coil fitting exactly cloſe to that of the preceding one, and being made to ſtick to it, by means of a glue, or any proper cement. A tube compoſed in this manner, of a ſingle ſtratum, may ſerve for ſome purpoſes: for other purpoſes the ſtratum, thus formed, may be ſtrengthened by a ſtratum of paper, or linen, or other cloth, either within ſide or without. For others again, the ſtrengthening may be given by a ſecond ſtratum of thin wood, compoſed of ribands, of which the grain runs in a direction parallel to that of the axis of the ſpiral. For others again, on the firſt wind another, turning in the oppoſite direction. Two ſtrata, thus applied to each other, may be cemented together, not only at the edges, but throughout the whole extent of their contiguous ſurfaces. In this way, tubes may be made, either round or oval, or even angular, ſo long as the angles are not ſharp enough to break the texture of the wood, or other ſubſtance. A tube, thus formed, will be more perfect if, whil it is on the mandril, but before the cement is ſet, it has been made to undergo an uniform preſſure

on

on the outſide, in the manner, for inſtance, in which metal is preſſed into ſhape by ſwedges. To make, in lengths, a tube for pipes of any length required, make the component lengths taper, in ſuch a manner that the ſmaller end of one ſhall fit into the larger end of another. To make a bent tube, the ribands, if applied with the ſame regularity as above ſuppoſed, muſt, it is plain, have their edges not parallel to each other, but ſometimes converging, ſometimes diverging, in ſuch manner as that the riband ſhall be broader when it comes to the outer part of the bend, and narrower when it comes to the inner. In this manner, tubes, though bent, may be made without any difficulty, ſo long as the diameter of the tube is either all along the ſame, or tapering, and the bend ſuch as will admit of the mandrils being drawn out of the tube: where no ſuch degree of regularity takes place, different contrivances may require to be employed. Firſt, In ſome caſes, where the value of the mandril is not regarded, for inſtance, if it be of clay, it may be got out piece-meal. Secondly, Where the mandril is to be preſerved, one method is, to uſe a hollow mandril; and, in the part where a ſwell, for example, is to be, let it be pierced, or laid open, leaving only ſo much ſubſtance as is neceſſary for ſtrength. Over the part thus laid open, lay at each end a bag, compoſed

poſed of ſome flexible ſubſtance, leather, for example; have ready a mould, opening in two cheeks, like ſwedges, to the ſize and ſhape of the ſwell; at one end of the mandril introduce any kind of powder, ſuch as ſand, ſawduſt, &c. which, when rammed, ſhall fill up the bag to the ſwell required; the bag being ſupported externally, and kept to its ſhape by the mould, which is then to be taken off. Having now formed the tube upon the mandril, bore or pick out a core from the ſand or ſawduſt; the bag may thus be emptied, and the mandril may be drawn out. But, to enable it to be drawn out, it is evident, that at the open or perforated part of it, where it is enveloped by the bag, its diameter muſt have been reduced to the amount [illegible] he thickneſs of the bag. Thirdly, Inſtead [illegible] der, a fluid may, in moſt inſtances, be employed to more advantage. This fluid muſt of courſe be of ſuch a ſort as, when introduced into the bag, may be ſet by cooling, or any other means, by which it may alternately be made to aſſume the fluid or the ſolid form. The means employed to produce this alteration muſt, it is plain, be in every inſtance ſuch as ſhall do no injury to the materials of either the tube, the cement, or the mandril, (where that is intended to be preſerved,) and, at the ſame time, ſuch as admit of the fillings being eaſily got out, without the expence and inconvenience of leaving any conſiderable reſiduum in the tube.

In all thefe points of view, the fufible metallic compounds which liquify in a degree of heat not greater than that of boiling water, may be employed, in many inftances with evident advantage; efpecially as in this way you may omit altogether the bag, the formation of which will, on account of the puckers in it, be but a troublefome operation. In the inftance of a metal, fuch as iron, where, for want of a perfect fufion or welding, or for any other caufe, the fame mafs is in different parts of it liable to poffefs different degrees of ftrength, the compounding it of thin laminæ may be productive of an advantage analogous to what is obtained by decuffating or twifting, in the cafe of wood, fince, the thinner the laminæ, the more [illegible]rately their texture may be fcrutinized int[illegible] and, the more numerous they are, the greater the probability that, in a tube thus formed, the weaknefs will not, in any part of its length, be found to pervade the whole thicknefs. The component tubes may be twifted either in the fame direction, or in contrary directions. If in the fame direction, care fhould be taken that, in the fecond or outward fpiral, the joinings fhould not be brought to the line where thofe of the firft or inner fpiral are, but rather at the greateft diftance from that line: by this means, whatever imperfection refults from the line of junction in one thicknefs, will be covered by an entire coating in the other. If the ribands are twifted

twiſted in oppoſite directions, a ſimilar advan-tage will be obtained, except that at every point of interſection there will be a lozenge-ſhaped ſpeck, of which the comparative unſoundneſs or weakneſs will pervade both ſtrata; which ſpeck will of courſe be greater or leſs, according to the accuracy of the work. To remedy this imperfec-tion, if in any inſtance it were thought worth while, the ſpecks may be bored out, and the hole cloſed again, with a ſcrew of the ſame ma-terial with the main body of the tube. Several ſtrata, thus twiſted together, preſerve their uni-formity much better than a ſingle one of the ſame thickneſs would do, during the operations of ſol-dering, brazing, or weld[illegible] For theſe pur-poſes, they may b[illegible] heated [illegible] everberatory or other furnace, without [illegible] in contact with the fuel; and, if requiſite, they may be incloſed in a caſe, to defend them from the blaſt of air. Where welding is employed, it may be perform-ed either by percuſſion, applied to the end or aperture of the tube, ſo as, by ſhortening it with ſucceſſive ſtrokes, to cloſe the clinks left between the threads, (as in the mode called *jumping*, at preſent uſed for gun barrels twiſted in a ſingle ſpiral,) or by ſwedges, preſſing on the outſide, while a mandril, forced in, either at the ſame time or immediately after, ſerves to finiſh the inſide. It is obvious, that in this way may be

made piſtol and gun barrels. Cannon of any ſize may alſo be formed in this manner, inſtead of by caſting; and an infinite variety of articles, that at preſent are made ſolid, may thus, for lightneſs ſake, be made hollow, without prejudice to the requiſite degree of ſtrength, inflexibility, durability, or other conſiderations.

II. *Sawing by a reciprocate motion, uſually an up-and-down one.* The ſaw mills hitherto uſed have ſcarcely been employed to any other purpoſe than that of ſawing timber longitudinally into boards and ſcantlings. A ſaw mill of this ſort conſiſts of a ſaw-frame, moving up and down, in which one or more ſaws are fixed, and a horizontal bed, o[illegible] wh[illegible] piece of timber is held, while the bed [illegible]d on towards the ſaw: the ſaw-frame is confined to its courſe by fixed channels. By the up-and-down motion of the ſaw-frame, a progreſſive motion is given to the bed on which the piece lies, whereby, at every deſcent of the ſaw, the piece is cut to a certain depth, and at every aſcent the piece is advanced: this advancement is made by a rack and pinion, ſet in motion by a ratchet-wheel, of which a tooth is laid hold of by a claw, every time the ſaw goes up. Thus far, generally ſpeaking, I adopt the ſame contrivance in my ſawing-machine. Firſt, for diminiſhing the friction between the ſaw-frame and the channels it moves in, I employ friction wheels

wheels or rollers, ſo placed that the ſaw-frame is compleatly guided by them, without rubbing againſt any thing elſe: or an apparatus may be employed, conſiſting of a combination of levers, an example of which may be ſeen in what is called the parallel motion apparatus for the piſton rods, in Meſſrs. Boulton and Watt's ſteam engine. With reſpect to friction-wheels, if the ſaw-frame is to move in a direct perpendicular, or nearly ſo, I make uſe of four pairs of wheels, all of equal diameter; each pair connected with each other by a common ſpindle; the length of the ſpindle being determined by the extent of the ſaw-frame breadthways, ſo that, when the ſpindles are placed in the fixed part of the machinery, the wheels ſhall apply themſelves to the perpendicular bars of the ſaw-frame: the poſition of the four ſpindles ſhould be horizontal, and parallel to each other; at any rate, at right angles to the direction of the ſaw-frame. Two of theſe ſpindles ſhould be placed on the ſame level with each other, and a little below the bench or floor on which the piece to be cut is advanced: the other two ſpindles ſhould be placed over theſe, at a ſufficient height, according to the length of the ſaw-frame. The centres or bearings in which theſe ſpindles turn, ſhould be fixed in the frame-work of the machine, in ſuch manner as to be adjuſted to their perfect poſition by wedges, or otherwiſe,

in

in any of the ways in uſe among millwrights. Theſe friction-wheels, embracing thus the ſaw-frame on the front and back part of it, above and below, will inſure the ſtraightneſs of its motion in one direction. To confine it in the other direction, you may fix perpendicular ſlips to the ſaw-frame, ſo as to act againſt the ſides of the wheels; or you may apply additional wheels to the ſide of the ſaw-frame, in the manner thoſe abovementioned were applied to the front and back of it. If the motion of the ſaw-frame is to be horizontal, or very much inclined, the rollers on the upper ſide may be omitted. In caſes where, beſides the reciprocate motion, a progreſſive motion is given to the ſaw as it acts, its frame may move between two [illegible] of cylindrical rollers, the axes of which ar[illegible]ed in the direction of the progreſſive motion of the ſaw: for example, in the cutting of ſtone by a horizontal motion, where the ſaw is to ſink perpendicularly as it enters the piece, for a ſimple machine for cutting one cut at a time, the ſaw-frame may, in its general form, agree with thoſe in uſe at preſent among ſtone-cutters; but, inſtead of the twiſted rope joining the upright bars of the ſaw-frame at their upper ends, the contraction of which rope is to ſtretch the ſaw faſtened at the lower ends, let the upper ends be joined together firmly by an additional horizontal fixed bar; or the horizontal bar, uſed

at

at preſent for no other purpoſe than that of reſiſting the action of the rope, may be made of ſufficient breadth and ſtrength to reſiſt the force with which the ſaw is to be ſtretched. The ſtretching, on this plan, may be performed by ſcrews, or otherwiſe, as in the ſaws for cutting wood. For guiding a ſaw-frame of this ſort in its courſe, theſe uprights may be made broad enough to ſlide to and fro the whole length of the ſtroke, between cylindrical rollers; which, in this poſition of the ſaw, muſt be perpendicular, turning upon perpendicular axes, ſupported by fixed frame-work. Theſe rollers muſt be of ſufficient length, that is, of ſufficient height to guide the ſaw-frame from the elevated ſituation which it occupies at the entrance of the ſaw into the ſtone, to the inferior ſituation which it occupies when the ſtone has been cut through. It is evident that, in this caſe, the uprights muſt be perfectly ſtraight and out of winding, as well with reſpect to each other as with reſpect to the ſaw. Where ſeveral cuts are to be made in a ſtone at once, the apparatus will require ſome ſuch variations as the following: conceive an oblong frame compoſed of two parallel longitudinal bars, joined towards each end by two parallel tranſverſe bars; between theſe tranſverſe bars are fixed the requiſite number of ſaws, ſo as to be ſtretched by ſcrews, or otherwiſe, in the ſame manner as ſaws

for

for cutting wood. This frame is of ſuch dimenſions as to receive within it the largeſt block which the apparatus is intended to ſaw, in ſuch manner, that as the ſaws in cutting ſink into the block, the block may thus riſe up as it were within the frame: moreover, in point of length, to the length of the longeſt block which the machine is intended to cut, muſt be added a further length, equal to that of the ſtroke. This horizontal ſaw-frame, in which the ſaws are ſtretched, may be guided, and confined to its courſe, by a vertical frame, ſet down upon the middle line of it, and firmly connected with it by braces. This vertical guide may be of the ſame figure as the vertical ſaw-frame above deſcribed, for cutting with a ſingle ſaw, and confined in the ſame way to its courſe, by perpendicular rollers.

To return to wood. In the preſent ſaw-mills, it is in the deſcent of the ſaw that the ſaw cuts, and in its aſcent that the piece moves on to it; on this account, though the motion of the ſaw is perpendicular, the poſition of the front or cutting part of it is inclined, the upper end overhanging the piece as much as the ſaw is intended to cut. In this caſe, to vary the length cut at a ſtroke, the angle of inclination muſt be varied. I find a convenience in giving ſuch a poſition to the ſaw, as that the points of the teeth ſhall be in a line nearly parallel to its motion; in which caſe, I make the piece advance

advance while the ſaw is cutting in its deſcent; thus, by regulating the advancement of the piece alone, I can regulate the length of the cut, the ſaw remaining always in the ſame poſition. I have ſometimes advanced the piece by a weight; but then, the weight ſhould be prevented from acting while the ſaw is aſcending. For ſawing a veneer, that the ſaw may work the eaſier, and the ſaw-duſt have the more room to eſcape, I fix to the bench or floor a wedge, the edge of which applies itſelf as near as poſſible to the back of the ſaw, ſo as to enter into the ſaw-kerf as the piece is advanced, and open it more or leſs, according to the ſharpneſs of the wedge. If a thin piece is to be cut from a thick one, a veneer, for example, from a thick block or log, then one ſide of this wedge ſhould ſtand in a line with that ſide of the ſaw which is toward the thick part of the piece, ſo that the inclination of the wedge ſhall bear off the thin part only. If the piece is to be cut in the middle, or nearly ſo, then the wedge may ſtand ſo as for the middle line of its thickneſs to be ſtraight with the middle of the thickneſs of the ſaw; thus, by varying the poſition of this wedge, the two parts into which a piece is cut may be borne off from the ſaw, each more or leſs with reſpect to the other, according to their relative degrees of flexibility: if two cuts are to be made in a piece,

ſo as to divide it into three parts, each of the two ſide-parts may thus be borne off from the middle part. If the friction of the piece againſt this wedge be conſiderable, you may place a cylindrical roller cloſe behind the wedge; or you may put friction-rollers in theſe wedges, ſo that, when the piece is advanced ſo far as to bear upon the rollers, the ſides of the wedge will be no longer rubbed againſt. If the action of the wedge, by thus bearing off one of the parts, is ſo ſtrong as to bend the whole of the piece out of its direction, this effect may be counteracted by a roller, ſtationed juſt before the teeth of the ſaw, ſo as, by a ſpring or weight, to preſs againſt the ſide of the piece, and keep it to its direction. If, to make a ſaw ſtiffer or ſtronger, it be made thicker at the back, like a knife or razor, although it would work very hard till the whole of the ſaw had entered the piece, yet, by placing a wedge or cylindrical roller cloſe behind the back of the ſaw, the thin piece of veneer would, as ſoon as it reached the roller, be borne off, ſo as no longer to be touched by the thick back of the ſaw: this back may be either of the ſame ſubſtance with the ſaw, or may be faſtened to the ſide of it. A caſe in which a ſaw, thus ſtrengthened, is particularly requiſite, is where, for cutting as little as poſſible from the rough ſide of a piece, for the purpoſe of making it even, the ſaw will, by

by reaſon of the inequality of reſiſtance, be apt to be thrown off to the outſide, inſtead of penetrating the ſubſtance without deviation from the ſtraight line. To confine the ſaw the better to its direction, and prevent its being twiſted by the above or any other cauſe, I ſometimes employ a pair of guides, conſiſting of pieces of hard wood, or metal, having each of them a ſlit, in which the ſaw itſelf moves, and by the ſides of which the whole breadth of the ſaw, the teeth only excepted, is embraced: one of theſe guides is fixed as near as poſſible above the upper ſurface of the piece, the other, as near as poſſible below the under ſurface. It is plain that, to move eaſily in theſe guides, the thickneſs of the ſaw muſt be very regular.

For croſs-cutting, I give the ſaw a ſort of frame, in which, inſtead of the ſaw's being ſtretched between the two uprights, the horizontal bars are made to extend beyond the upright ones; the ſaw being fixed in a direction which, with reſpect to its frame, is at right angles to that which it aſſumes when fixed for longitudinal cutting, that is to ſay, in a direction croſſing the ſliding bed, inſtead of parallel to it. Of theſe horizontal bars, the projecting part muſt be of ſuch a length as to admit of the thickeſt pieces being cut through, before it is ſtopped by the perpendicular bars. Provide the ſliding beds now

with ſtops and ſupports, proper for confining the piece to the poſition required, and, by preſerving the ſame ſtops and ſupports, any number of pieces, whether ſtraight or curved, may be cut to the ſame length and angle: thus much, where the cut is to go through. Now, ſuppoſe it is to ſtop ſhort at a certain depth: if this partial cutting is to be performed on a ſingle piece only, or a ſmall number of pieces, it may be done by ſtopping the action of the machine, as ſoon as the cut is obſerved to have attained the depth required. When a certain number of pieces are to be cut to the ſame depth, it will be proper to adjuſt the machinery in ſuch a manner that each piece ſhall be cut, one after the other, invariably to the ſame depth. To produce this effect, it might be ſufficient to adjuſt matters ſo that the action of the machine ſhall be ſtopped by an obſtacle oppoſed to the bed, or to the pieces, as they are drawn on againſt the ſaw; but, if the mode of advancement above ſpoken of be uſed, ſuch ſtoppage would damage the machine. To avoid this inconvenience, effect the ſtoppage rather by diſcontinuing the motion of its ſliding bed from that of the ſaw, which will thus play up and down, without acting any more upon the piece. This effect may be produced in a variety of ways: where, for example, the depth of the cut does not exceed the quantity that correſponds to

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a revolution of the ratchet-wheel, fill up one of the notches into which the claw muſt fall, to pull on the wheel, ſo that, when that part of the ratchet-wheel comes to the claw, it ſhall no more be laid hold of. When the depth is greater than as above, adjuſt to the bed ſomething that, when the bed has advanced to the required diſtance, ſhall apply itſelf to the claw, and prevent its laying hold of the ratchet-wheel. In this way, tenons, for example, may be ſhouldered by the apparatus for croſs cutting; and cut lengthwiſe, by the apparatus for longitudinal cutting. For the latter purpoſe, if many ſimilar tenons are to be cut, it will be more expeditious to uſe two ſaws in the frame, the diſtance between them being adjuſted to the thickneſs of the tenon.

For cutting curve faſhion, the ſaw may be fixed in its frame, either in the manner juſt deſcribed, or, according to the nature of the work, in any manner that admits of the ſupports being ſituated out of the way. By a ſaw thus playing up and down, to cut a curve, you need only make the piece to advance in a direction adapted to ſuch curve.

In cutting circularwiſe, (in cutting fellies of wheels, for example,) the buſineſs of directing the courſe of the piece may be performed by a pair of calipers, lying flat on the bench or floor, and moving about a centre; which calipers are, at their extremities, furniſhed with teeth, proper for lay-

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ing hold of the ends of the piece: the arms of these calipers muſt be of a length equal, at leaſt, to the radius of the circle to be cut. To prevent their ſeparating, when the piece introduced between them is to be laid faſt hold of, employ a croſs-bar from one arm to the other, with pin-holes adapted to the different angles to which there may be occaſion to open the calipers, for receiving pieces of different lengths. The operation of advancing may, in this caſe, be performed in the ſame manner as in that of rectilineal ſawing; except that the rack, inſtead of being ſtraight, muſt be bent to the ſegment of a circle, and fixed concentrically to the calipers.

Pieces may be cut to an elliptical form, by the apparatus deſcribed above for cutting circular pieces; only, for holding the piece, ſubſtitute an oval trammel, inſtead of the calipers. But, in the following manner, a piece may be cut to any irregular curve: cut firſt a thin piece of wood to the curve required, and near each end bore a hole, to receive a ſharp point, to ſerve as a tracer; lay this mould on the ſaw-bench, in ſuch manner as that one end of the curve ſhall touch the teeth of the ſaw, and point in a direction along the ſide of it; now advance the mould in the direction it aſſumes, in conſequence of its being kept, throughout its progreſs, as near as poſſible flat againſt the whole breadth

breadth of the ſaw, and the points fixed near each end will have traced, on the bench, the line they reſpectively deſcribed, during the moving on of the mould; then, according to each of theſe lines, cut in the bench a channel, of ſufficient breadth to receive a ſtout pin; now lay the mould on the piece to be cut, and mark on the piece the ſpots where the points or traces were placed in the mould; at theſe two ſpots bore holes, to receive a ſtout pin in each, correſponding to the traces in the mould. Lay the piece on the bench, with the pin at each end inſerted into the correſponding channel; then will the end of the piece be applied, as the mould was before, to the teeth of the ſaw; and, when the ſaw is ſet in motion, if the piece be advanced, the pins ſliding along in the channels, the piece will thereby be guided ſo as to be cut to the curvature of the mould. In this way, curved pieces, the ribs, for inſtance, of a ſhip or boat, may be cut out.

How to cut to bevellings, and to windings. The angles which two contiguous ſurfaces of a piece form together at their meeting, and which is not a right angle, is called by ſome workmen the bevelling. The cutting a piece then to any bevelling, the bevelling remaining the ſame, may be eaſily effected, by the poſition in which the piece is confined on the ſliding-bed, and that in longitudinal ſawing

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as well as croſs cutting: but, if the bevelling is required to vary in the courſe of the cut, ſo as to produce a winding ſurface, forming certain given bevellings, and thoſe different ones at different poſitions of its length, for this purpoſe, the following apparatus may be employed. Let the frame or bench on which the ſliding-bed moves, when there is a ſliding-bed, and on which the piece itſelf moves, when there is no ſliding-bed, be made to tilt or turn on a pin or gudgeon at each end, ſo placed as that, if joined, they would form an axis, paſſing lengthways through the middle of the bench, at the height of the upper ſurface of whatever is uſed to ſupport the piece, and through the ſaw. On one ſide of this axis let the bench be loaded, in ſuch a manner that, if it had no ſupport, it would drop on that ſide, till it aſſumed nearly a vertical inſtead of a horizontal poſition. From the under part of this ſide, project a leg or ſupport downwards, towards the floor; then let a wedge, or waved mould, which may be called a *director*, the motion of which is connected with that of the piece to be ſawn, be made to ſlide on the floor under this leg; and let the thickneſs or height of this director, at different parts of its length, be adapted to raiſe the leg of the bench more or leſs, according to the angle the bench ſhould make with the ſaw, itſelf moving all the while invariably up and down, in a perpendicular direction.

Reciprocate

Reciprocate ſawing machines have never, I believe, been applied to cutting any other ſubſtances than wood or ſtone; beſides theſe, I apply them, not only to ivory, bone, and ſuch ſubſtances as are uſually cut with edge-tools, but to metal and other ſubſtances, ſo as to perform, with machinery, all ſorts of ſawing that are now performed by hand. Theſe machines may not only be worked by any of the greater forces applicable to mill-work, but alſo by manual labour, and that to great advantage, where a number of pieces are to be cut alike. The ſize and ſtrength of the machine muſt of courſe be adapted to the work it is to do; and, when human labour is to produce the motion, it may be communicated, not only by a crank and fly-wheel, worked by a winch or treadle, but by a lever, like a pump-handle, or in any other of the modes uſed for turning-lathes, or other machines. The ſaw is not the only tool to which a reciprocate motion may thus be given with advantage. By a ſimilar apparatus, it may equally be given to an edge-tool without teeth; to a kind of chiſel, or gouge, or knife; as alſo to a file, raſp, or any other grinding or poliſhing inſtrument, while the piece is preſented to the action of the tool, in the direction required, and in a manner ſuited, in each caſe, to the nature of the work.

III. *Work-*

III. *Working by a reciprocate lathe.* From the reciprocate motion, as applied to sawing, it will be eaſy to conceive a new mode of working by means of an engine, which I call a recipro-cate-lathe. I call it a lathe, becauſe it is by the motion of the piece that the tool is made to act; the tool itſelf being ſupported on a reſt. In a turning-lathe, the motion of the piece is circular or oval, or at any rate in a current; whereas, in the reciprocate-lathe, the motion of the piece is ſtraight, or, if curved, not rotary, but backwards and forwards, or, in one word, reciprocate. Suppoſe that, to either of the reciprocate ſaw-frames, a piece of wood, for example, be fixed, inſtead of a ſaw, ſo as to play up-and-down, as the ſaw did. Now it is plain, that if a tool of any kind, like a turning-tool, be held againſt the piece of wood, it may be made to receive a cut, which ſhall in the longitudinal direction be ſtraight, and in the tranſverſe direction of any given figure, depending on the ſhape, or manner of application, of the tool. A man uſed to turning will thus make any ſtraight moulding, as eaſy as he does a circular one in a turning-lathe. So moſt of the contrivances uſed in engine-lathes, to vary the figure of the piece, may, whenever it may be thought worth while, be applied to this reciprocating lathe. In this manner, a piece of any ſort of material, ſuch as wood, ivory, metal, ſtone,

&c.

[illegible] be h[illegible] not only for the purpoſe of receiving its form, but for the purpoſe of being poliſhed; the inſtrument, whatever it be, that is made to act on the piece, being preſented either by hand, or in any other advantageous manner, according to the nature of the work.

Under the head of ſawing, there was occaſion to mention the neceſſity, in ſome caſes at leaſt, of the ſaw's being of an exact and regular thickneſs. Sometimes, to do without being ſet, it ſhould be thicker at the teeth than at the back; yet, however tapering in the direction of its breadth, in that of its length it ſhould be all along of a thickneſs exactly parallel. In the methods hitherto uſed for grinding ſaws, neither this ſhape, nor any other, can be given them with any degree of accuracy. A reciprocate-lathe is particularly ſuited to this purpoſe: the ſaw may be ſtretched as if it were for cutting, then, by holding an edge-tool or grinding-inſtrument to one ſide, a ſupport being provided on the other, the two ſides may be wrought ſucceſſively; or, by putting two tools, one on each ſide, acting one againſt the other, both ſides may be done at once. Theſe oppoſite tools may be made to cloſe in upon the ſaw, by ſcrews or otherwiſe, till it is reduced to the form required. Inſtead of this particular conſtruction of the frame uſed for holding the ſaw, may be ſubſtituted one more ſuitable to the taſk of ſup-

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porting the piece againſt the action of the [illegible] and this frame, which may be called the reciprocating lathe-bed, may be furniſhed with ſtops and contrivances, for the more ready laying faſt hold of the pieces to be worked. The motion given to a reciprocate lathe, need not be confined to the perpendicular one uſually given to the ſaw in a ſawing-machine. No experienced engineer will be at a loſs to produce a reciprocate motion to any extent, and in any direction required, perpendicular, horizontal, or inclined. The motion of a crank ſeems particularly applicable to produce this reciprocate motion, where the extent of it is not too great; and the ſort of crank for this purpoſe, ſhould be ſuch in which the crank-pin being provided with different holes in a flanch, at different diſtances from the centre, (in any one of which holes it may be inſerted,) or being made moveable in a ſlit, the extent of the reciprocate motion may thus be varied at pleaſure. By varying the extent of the motion, the lathe may eaſily be adjuſted to working any ſuch piece as, though ſtraight to a certain extent, has at the extremities of the ſtraight part projections, ſuch as would prevent the application of a plane. A mode in which the action of this reciprocate-lathe may be varied, is by making the bed move or vibrate in the direction of the ſegment of a circle, an ellipſis, or any other curve,

c. [illegible], or, [illegible]ort, in any other direction, by [illegible] of guides. See the article of ſawing, as applied to irregular curves.

IV. *Giving curvature by bending.* Bending is another, and in many inſtances more advantageous, mode of giving curvature to wood; and may be performed with or without ſteaming, as the caſe requires. Where the thickneſs required, compared with the ſharpneſs of the curvature, is ſuch as renders it impracticable to bend the piece intire, it may be divided for this purpoſe into different thickneſſes, with very little if any loſs of ſtrength, and (if the ſtrata are connected by proper faſtenings) with a degree of ſtrength far ſuperior to what a piece of the ſame dimenſions would poſſeſs, if grain-cut. The uſe of ſteaming wood, for the purpoſe of bending it, is to ſupple it, ſo as to enable it the more eaſily to be brought to the form required; as well as to render it more apt to ſtay in that form, after the preſſure by which it was originally brought to that form has been removed. The effect of ſteaming the wood, is the applying heat and moiſture to it. If it has already moiſture enough, as in the caſe of green wood, heating in any other way, without the application of ſteam, may ſuffice; or the effect may be produced by heating and wetting at the ſame time. The above three modes of ſuppling, by heat and moiſture, have been practiſed

practiſed from time immemorial in Ruſſia, and applied to wheels, and ſome other ſort of wood-work. In England, they, or ſome of them, have been long applied to the bending of planks for ſhips, in the King's and other dock-yards; by Meſſrs. Jacob and Viny, under a patent now expired, for wheels; and by Mr. Bevan, under a patent ſtill in force, to circular wooden ſaſhes, ſoffits, fan-lights, door-mouldings, and hand-rails for ſtairs; and perhaps, in ſome few inſtances, by cabinet and chair-makers in general, without patent; though, in no inſtance that I have ever heard of, here or elſewhere, has the expedient been recurred to, of dividing a piece, for this purpoſe, into thickneſſes. But, where curvature is required, there is no branch of wood-work to which, by help of the expedient of diviſion into thickneſſes, this mode of curvature may not be applied; and that, even in the caſes where the pieces at preſent employed are of the greateſt thickneſs. In this manner, curvature may be given, where required, to the wood-work of all ſorts of engines, and of carriages of all ſorts; alſo, to the timbers of all ſorts, that are, or may be, deſigned to receive a curved ſhape, for the purpoſe of being employed in buildings; and to any of the timbers, without exception, that are, or may be, employed in the conſtruction of boats or veſſels, ſhips of the largeſt claſs not excepted; in

in which latter instance, a vaſt ſaving in point of quantity and value, as well as a conſiderable increaſe in point of ſtrength, might be effected.

Screws may alſo thus be formed of wood. The male ſcrew, by bending the thread about its ſtem; the female, by twiſting a ſlip round a falſe ſtem or mandril, on which it is confined by a ſhallow channel, or otherwiſe, to the proper angle, while it is forced into a hole prepared to receive it: a little glue, on the outſide of the ſpiral ſlip, would be ſufficient to hold it in its place, while the falſe ſtem is drawn out; afterwards, the male-thread, and the ſpiral ſlip, the interſtices of which conſtitute the female-ſcrew, may be ſecured in their reſpective poſitions, by pins, or other means.

In the operation of bending, a very material caution is, that as faſt as you force any piece to adapt itſelf to the curvature of the mould to which you are bending it, you apply a preſſure, by means of ſcrews, or wedges, &c. to that very part, and ſo all along the piece, particularly at the ſharpeſt convexities; not truſting to the force applied to any other part of the piece, leſt ſuch force, though ſufficient to keep the piece to its curvature, ſhould not prevent the exterior fibres from ſtarting out. In the forming, for example, of ſhip-ribs of all ſhapes and ſizes, in order to ſuperſede altogether the uſe of crooked-grown timber, in every inſtance where ſtraight would be cheaper,

cheaper, there needs no more than the making uſe of one or other of the two methods following. Firſt, having formed a mould or block the ſhape of the rib in queſtion, comprehending the whole of its extent from top to top-ſide, (that is, on both ſides the keel,) bend the component parts of the rib, according to the ſhape of the block, and faſten them together; then, to confine the whole rib in its curvature, apply ſtays or croſs-bars, according to the places where the form would be moſt apt to change, and ſo convey the rib, ſtays and all, not taking the ſtays off, till the rib has been ſufficiently confined to its curvature, by the connexion given to it with the planks, beams, and other parts of the ſhip. Or, ſecondly, you may form the ſhell of the ſhip firſt, without timbers, beginning to build it as it were by the planks, uſing only a ſet of temporary moulds or falſe ribs, to determine the poſition of, and give a temporary ſupport to, the planks: this done, inſert the timbers afterwards, preſſing and binding the component parts ſucceſſively into their places, and removing the falſe ribs, in proportion as the real ones are put together and ſecured. Or, thirdly, inſtead of the falſe ribs, you may inſert a ſufficient number of real ribs, put together as in the firſt method, and then proceed with the plank and the reſt of the ribs, as in the ſecond method. As to bending, it may, in this caſe, be performed

pe[illegible]fo[illegible]m[illegible]d with or without the affiftance of fteam-[illegible] and with or without the ufe of the expedient of dividing into thickneffes, according as the degree of curvature may require. In clinker-work built boats, the ribs have fometimes been inferted by bending them to the planks, but this only in boats of the flighteft clafs; and, I believe, in no inftance in which the pieces of wood employed for the ribs have exceeded an inch in thicknefs. In this kind of work, to make the junction between rib and plank clofe and firm, the notches or receffes left by the lapping over of the planks, ought firft to be filled up at the place of infertion of each rib, and the furface thus made flufh, before the rib is inferted.

On account of the great length of this Patent, we have (contrary to our ufual cuftom) thought proper to divide it: the conclufion fhall be given in our next.

XXXV. *Specification of the Patent granted to* THOMAS DANFORTH, *of Charles Town, in the Province of Maſſachuſett's Bay, Gentleman; for his Invention of a Method of condenſing the Vapour ariſing in Diſtillation.*

Dated July 19, 1773.—Term expired.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE, that in compliance with the ſaid proviſo, I the ſaid Thomas Danforth do hereby declare, that my ſaid invention is, to make the worm veſſel, or the veſſel of whatever form, that contains the water to cool the worm or veſſel containing the ſteam or vapour to be condenſed, (whether the ſteam veſſel be a worm, ſtraight tube, or of any other form,) in ſuch manner that it may act as the inſtrument called a ſyphon or crane, and upon the ſame principles, by making it air-tight, except a communication, by a tube, or a part of the veſſel, with the water that ſupplies it, and an aperture, from a tube, or part of the veſſel itſelf, below the horizontal level of the ſurface of the water in the reſervoir where it firſt enters, for the water to flow out, at the ſame time, and in the ſame quantity, that it flows into the veſſel, from the reſervoir or ſupply of water. In witneſs whereof, &c.

XXXVI.

XXXVI. *Description of an improved Method of laying Water-Pipes. In a Letter to the Editors.*

WITH A PLATE.

GENTLEMEN,

THE great inconvenience occasioned by the breaking of the pipes in the ſtreets of the metropolis, and the troubleſome and inartificial method of repairing the breaches, led me to conſider if it were not poſſible to adopt a more certain and expeditious method of doing that part of the buſineſs, without enhancing the expence to the proprietors: whether I have ſucceeded or not, muſt be determined by experience.

It will not be amiſs, firſt, to take notice of the method of laying pipes in the general way, as it may be in the power of thoſe who ſuperintend that kind of work, to prevent much waſte of water, as well as inconvenience to paſſengers, by a well concerted method of jointing; which, though it may appear at firſt to be too elaborate, will not be found ſo. It being ſo often called for, a habit will ſoon be formed, by which, accuracy

 and

and difpatch will be obtained; and the workmen will be able to do that in one hour which [illegible] may require three or four; not from any di[illegible]culty in the thing itfelf, but from the novel[illegible] of different tools, to effect that which they have long effected in a different way.

The prefent method, as far as I am informed, is to bore the faucet with a proper bit, and fit in the fpigot with the axe and the drawing-knife. This method *may do*; but workmen are apt to regard particular circumftances. In cold weather, over the fhoes in mud, drenched with rain, or pelted with hail or fnow, it is hardly reafonable to expect that men will be as attentive to this part of their duty as in more agreeable weather, and the joint is fitted with hafte, and got rid of as foon as poffible. But, were not that the cafe, even the mode of fitting the fpigot is liable to great uncertainty. The faucet is bored quite round; the fpigot is rounded by the eye, and, fo long as it is taper, and will go into the faucet, it is thought to do, and, when laid in the ground, is out of the reach of detection.

The manner in which fuch joints go together, will be feen at A, Fig. 1, (Plate XIV.) where the *quantity of fitting*, if I may ufe the expreffion, is only juft at the breech of the faucet; and, though it is a joint, and will hold water, its durability can be only in proportion to that quantity

tity of fitting; and I ſuppoſe it may be taken for granted, that if the quantity be two inches, and the joint ſhould endure ſeven years, it would, if the ſpigot were to fit all the way, (ſay twelve inches,) in a pipe of ſix inches bore, endure forty-two years; and this without any additional expence, admitting the wood to continue ſound ſo long. There is a good reaſon why the ſpigot ſhould go in no farther than it fits, be that more or leſs; for the interſtice is ſure to be filled with mud, which becomes a means of haſtening the decay of the whole joint; but, the farther the ſpigot enters, provided the butt out of which the faucet is formed is large enough to admit it, the more intire will be the joint *.

Another circumſtance muſt be taken notice of here. As to forming the ſpigot, it is done by the eye, as I before obſerved; and, if it ſhould prove to be round, it muſt be by accident, for it is ten to one but it is oval, or perhaps angular, at beſt only approaching to a circle: for this reaſon, I would adviſe ſome more accurate and expeditious method of *rounding* the ſpigot; and it ſeems to me, that a tool may be contrived, in ſuch a manner as that, by turning a handle like that of an auger, the ſpigot may be rounded to the utmoſt preciſion. Such a tool is repreſented at

* B, at Fig. 1, ſhews how a joint ſhould be fitted.

Fig.

Fig. 2, where *d* is a plug or tompion of wood, with a hole through the length of it, and bushed with brafs. This hole is to admit the round rod, ftem *a b*, with a fquare part, having a mortife in it, into which is inferted the arm *c*, which is faftened there, by the key or wedge *e*, according to the diftance required from the centre, or the diameter of the fpigot. This arm is to have a knife fitted to it, and faftened with fcrews, to admit of its being ground as occafion may require, and plugs fhould be provided, of the feveral diameters of the pipes. I need not fay that this arm fhould be made very ftrong, or that the plug fhould be long enough to keep the ftem fteady. By this means, the bit that bores the faucet, and the cutter which rounds the fpigot, may be made to correfpond fo exactly, that they will fit each other to any length; and the joint will be tight and fteady, and as firm as it is poffible for fuch a joint to be, with lefs trouble than by any common method now in practice.

It remains to confider the moft proper means of repairing a breach, in a main of pipes already in the ground. My objection to the common practice is, that it is flovenly, and flavifh; and, though it may anfwer a temporary end to the prefent proprietor, it is fure to entail trouble and expence on his fucceffor: to fay nothing of the inconvenience the ftreets are fubject to; or of the

laborious

laborio... and perplexing ſituation the men are often...es in, when effect ng a job of this kind.

In order therefore to do this properly, we muſt have recourſe to a different method of jointing; and, for this purpoſe, both ends of the pipe are to be fauceted, ſo as to receive a caſt-iron ferril or barrel, of a dimenſion ſuited to the bore of the pipe, a ſection of which may be ſeen at Fig. 5, together wlth the ſection of a whole joint; and, if the ſmaller end of the pipe is rather ſlight, it may be ſecured by a band; theſe faucets ſhould be bored accurately to the mould of the barrel, as far as to the cylindric part of it.

Fig. 3, repreſents the pipes prepared, and ready to be fixed in their places. For this purpoſe, I would recommend a ſcrew paſſing through a beam, as in the figure, having each end looped to the old pipes by a chain, and ſupported, until the ſcrew comes into action, by a pair of treſſels, or any temporary method, as circumſtances may direct: then, having a ſaddle, as X, laid on each pipe, the ſcrew will preſs them down, with eaſe and effect, without diſturbing the joint of the other pipes already laid *. All the care required here

* I cannot help thinking, but that the violence uſed in forcing down the pipes with the rammer, muſt extend itſelf to a conſiderable diſtance, and increaſe the evil it is intended to remedy; if it be conſidered that the beat of a watch may

here is, to take an accurate meaſure of the length, and there is no difficulty in doing that, but it will be neceſſary to ſupport the lower end of each pipe, by ſomething ſolid, that it may not ſink beneath its proper line of direction.

Perhaps the two barrels in the lower ends may be diſpenſed with, as it is certain the angle at the lower joints is but half as great as the angle at the place where the two new pipes meet; and the barrel being introduced there, will alſo divide that angle, and make it but half of what it is in the common way *. Indeed, this was the firſt thing which ſtruck me as calling for a remedy; and perhaps it may be found, that ſuch attention to this one joint, would greatly facilitate the trouble, and do away the uncertainty, attending this part of the buſineſs.

Fig. 4, repreſents the ſtate of Fig. 3, when brought down to the proper place.

I am, &c.

J. C. Hornblower.

Pittman's Buildings, City Road,
Feb. 1, 1799.

may be diſtinctly heard from one end of a fifty foot piece of bulk to the other, it will not be difficult to draw ſuch a concluſion.

* This will appear by looking at the dotted lines, Fig. 6.

XXXVII.

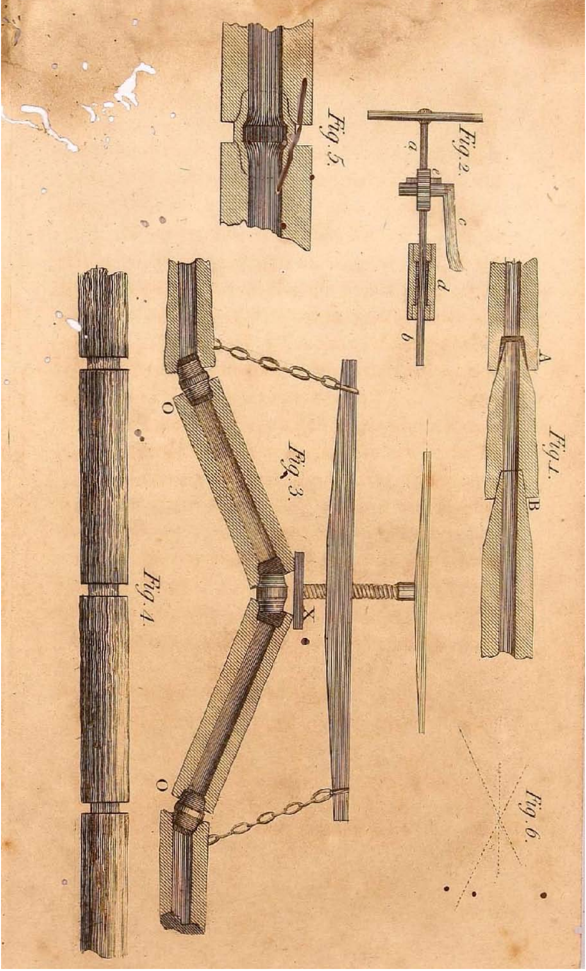


Fig. 1.
A
B
Fig. 2.
a
c
c
d
b
Fig. 3.
O
X
O
Fig. 4.
Fig. 5.
Fig. 6.

XXXVII. *Conclusion of Count* RUMFORD's *Inquiry concerning the chemical Properties attributed to Light.*

(From Page 199.)

Experiment No. 9. INTO a thin tube of very fine colourless glass, ten inches long, and six-tenths of an inch in diameter, closed hermetically at its lower end, I put as many pieces of charcoal, about the size of large peas, as filled the tube to the height of two inches; and, having poured on them as much of the aqueous solution of nitro-muriate of gold as nearly covered them, exposed the tube, with its contents, to the action of the direct rays of a very bright sun.

In less than half an hour, small specks of revived gold, in all its metallic splendour, began to make their appearance here and there on the surface of the charcoal; and, in six hours, the solution, which at first was of a bright yellow colour, became perfectly *colourless*, AND AS CLEAR AND TRANSPARENT AS THE PUREST WATER.

 The

The ſurface of the charcoal was, in ſeveral places, nearly covered with ſmall particles of revived gold; and the inſide of the glaſs tube, in that part where it was in contact with the upper ſurface of the contained liquid, was moſt beautifully gilded.

This gilding of the tube was very ſplendid, when viewed by reflected light; but, when the tube was placed between the light and the eye, it appeared like a thin cloud, of a greeniſh blue colour, without the ſmalleſt appearance of any metallic ſplendour.

From the colour, and apparent denſity of this cloud, I was induced to conclude, that the gilding on the glaſs was leſs than *one millionth part of an inch* in thickneſs.

This intereſting experiment was repeated ſix times, and always with nearly the ſame reſult. The gold was completely revived in each of them, and the ſolution left perfectly colourleſs; in moſt of the experiments, however, the ſides of the glaſs were not gilded, all the revived gold remaining attached to the ſurface of the charcoal.

In two of theſe experiments, I made uſe of pieces of charcoal which had been previouſly boiled ſeveral hours in a large quantity of diſtilled water, and which were introduced *wet*, and *hot*, into the tube, and immediately covered by the ſolution, to prevent them from imbibing any

any air; and, in different experiments, the solution was used of different degrees of strength.

I plainly perceived that the experiment succeeded best, that is to say, that the gold was *soonest revived*, in those cases in which the solution was *most diluted*: one of the experiments, however, and which succeeded perfectly, was made with the solution so much condensed, that it was nearly at the point at which it became disposed to crystallize *.

On examining, with a good microscope, the particles of revived gold which remained attached to the surface of the charcoal, after it had been dried, I found them to consist of an infinite number of small scales, separated from each other; not very highly polished, but possessing the true metallic splendour, and a very deep and rich gold colour.

The gold which attached itself to the inside of the glass tube, was in the form of a ring, about one-tenth of an inch wide, (badly defined however below,) and adhered to the glass with so much obstinacy, as not to be removed by rincing

* This agrees perfectly with the results of similar experiments made by the ingenious and lively Mrs. Fulhame. (See her Essay on Combustion, page 124.)

It was on reading her book, that I was induced to engage in these investigations; and it was by her experiments, that most of the foregoing experiments were suggested.

 out

out the tube a great number of times with water; it had, as has already been obſerved, a very high poliſh, when ſeen by reflected light.

Thoſe who enter into the ſpirit of theſe inveſtigations, will eaſily imagine how impatient I muſt have been, after ſeeing the reſults of theſe experiments, to find out whether gold could be revived from this aqueous ſolution of its oxide by means of charcoal, *without the aſſiſtance of light*, and merely by ſuch a degree of equal heat as could be given to it in the dark. To determine that important queſtion, the following experiment was made.

Experiment No. 10. A cylindrical glaſs tube, ſix-tenths of an inch in diameter, and ten inches long, cloſed hermetically at its lower end, and containing a quantity of a diluted aqueous ſolution of the oxide of gold, mixed with charcoal in broken pieces, about the ſize of large peas, was put into a fit cylindrical tin caſe, which was nicely cloſed with a fit cover; and the glaſs tube, with its contents, ſo ſhut up in the dark, was expoſed two hours, in the temperature of 210° of Fahrenheit's ſcale.

On taking the glaſs tube out of its tin caſe, I found the ſolution *perfectly colourleſs*, and the revived gold adhering to the ſurface of the charcoal.

On

On repeating the experiment, and uſing the ſolution nearly ſaturated with the oxide, the reſult was preciſely the ſame; the ſolution being found perfectly colourleſs, and the revived gold adhering to the ſurface of the charcoal.

I own fairly, that the reſults of theſe experiments were quite contrary to my expectations, and that I am not able to reconcile them with my hypotheſis, reſpecting the cauſes of the reduction of the oxide, in the foregoing experiments; but, whatever may be the fate of this, or of any other hypotheſis of mine, I hope and truſt that I never ſhall be ſo weak as to feel pain at the diſcovery of truth, however contrary it may be to my expectations; and ſtill leſs, to feel a ſecret wiſh to ſuppreſs experiments, merely becauſe their reſults militate againſt my ſpeculative opinions.

It is proper I ſhould obſerve, that the charcoal uſed in this laſt-mentioned experiment had been boiled two hours in diſtilled water; by which means, its pores had been ſo completely filled with that fluid, that the pieces of it that were uſed were ſpecifically heavier than water, and ſunk in it, to the bottom of the containing veſſel.

Having been ſo ſucceſsful in my attempts to reduce the oxide of gold, by means of charcoal, *in the moiſt way*, I loſt no time in making ſimilar experiments with the oxide of ſilver.

Experiment

Experiment No. 11. A ſolution of fine ſilver, in ſtrong nitrous acid, was evaporated to dryneſs, and the reſiduum rediſſolved in diſtilled water.

A portion of this ſolution, (which was perfectly colourleſs,) diluted with twice as much diſtilled water, was poured into a phial containing a number of ſmall pieces of charcoal; and the phial, being well cloſed with a new cork ſtopple, was expoſed to the action of the ſun's rays.

In leſs than an hour, ſmall ſpecks of revived ſilver began to make their appearance on the ſurface of the charcoal; and, at the end of two hours, theſe ſpecks became very numerous, and had increaſed ſo much in ſize, that they were diſtinctly viſible to the naked eye, at the diſtance of more than three feet. They were very white, and poſſeſſed the metallic ſplendour of ſilver in ſo high a degree, that when enlightened by the ſun's beams, their luſtre was nearly equal to that of very ſmall diamonds.

The phial, which was in the form of a pear, and about 1½ inch in diameter at its bulb, was very thin, and made of very fine colourleſs glaſs; the aqueous ſolution was alſo perfectly tranſparent and colourleſs; and, when the contents of the phial were illuminated by the direct rays of a bright ſun, the contraſt of the white colour of theſe little metallic ſpangles with the black char-

coal

coal to which they were fixed, and their extreme brilliancy, afforded a very beautiful and intereſting ſight.

As the air had been previouſly expelled from the charcoal, by boiling it in diſtilled water, it was ſpecifically heavier than the aqueous ſolution of the metallic oxide, and conſequently remained at the bottom of the bottle.

Experiment No. 12. A phial, as nearly as poſſible like that uſed in the laſt experiment, and containing the ſame quantity of diluted aqueous ſolution of nitrate of ſilver, and alſo of charcoal, was incloſed in a cylindrical tin box, and expoſed one hour to the heat of boiling water, in an apparatus uſed for boiling potatoes in ſteam, for the table.

The reſult of this experiment was uncommonly ſtriking. The ſurface of the charcoal was covered with a moſt beautiful metallic vegetation; ſmall filaments of revived ſilver, reſembling fine flatted ſilver wire, puſhing out from its ſurface, in all directions!

Some of theſe metallic filaments were above one-tenth of an inch in length. On agitating the contents of the phial, they were eaſily detached from the ſurface of the charcoal, to which they ſeemed to adhere but very ſlightly.

Theſe experiments were repeated ſeveral times, and always with preciſely the ſame reſults.

When

When the oxide of gold was reduced in this way, the revived metal appeared under the form of ſmall ſcales, adhering firmly to the ſurface of the charcoal. May not the difference of the forms under which gold and ſilver are revived from their oxides, in this proceſs, be owing to the difference of the ſpecific gravities of thoſe metals?

The following experiments, which were firſt ſuggeſted by an accident, were made with a view to inveſtigate ſtill farther the cauſes of thoſe effects which have been attributed to the ſuppoſed chemical properties of light.

Having accidentally put away two ſmall phials, each containing a quantity of aqueous ſolution of the oxide of gold and ſulphuric ether, in each of which the ether had extracted the gold completely from the ſolution, as was evident by the yellow colour of the ſolution having been transferred to the ether, and the ſolution being left colourleſs; in one of the phials, which happened to ſtand in a window in which there was occaſionally a ſtrong light, (though the direct rays of the ſun never fell on it,) I found, in about three weeks, that the oxide was almoſt entirely reduced; the revived gold appearing in all its metallic ſplendour, in the form of a thin pellicle, ſwimming on the ſurface of the aqueous liquor in the phial, and the colour of the ether which repoſed on it having

having become quite faint; while no viſible change had been produced in the contents of the other phial, which had ſtood in a dark corner of the room.

As theſe appearances induced me to ſuſpect, or rather ſtrengthened the ſuſpicions I had before conceived, that the ſeparation of gold from ether, under its metallic form, when a ſolution of its oxide is mixed with that fluid, is always effected by a reduction of the oxide by means of light, I made the following experiment, with a view to the farther inveſtigation of that matter.

Experiment No. 13. Into a ſmall pear-like phial, of very fine tranſparent glaſs, I put equal quantities of an aqueous ſolution of the muriatic oxide of gold and ſulphuric ether; and the phial, which was about half filled, being cloſed with a good cork, well ſecured in its place, was expoſed to the action of the direct rays of a bright ſun.

A pellicle of revived gold, in all its metallic ſplendour, began almoſt immediately to be formed on the ſurface of the aqueous liquid, and ſoon covered it entirely; and, at the end of two hours, the whole of the oxide was completely reduced, as was evident from the appearance of the other, which became *perfectly colourleſs*.

On ſhaking the phial, the metallic pellicle which covered the ſurface of the aqueous liquid was broken into ſmall pieces, which had exactly the

the appearance of leaf gold, poſſeſſing the true colour, and all the metallic brilliancy of that metal.

On ſuffering the phial to ſtand quiet, the aqueous liquor and the ether ſeparated, and moſt of the broken pieces of the thin ſheet of gold deſcended to the bottom of the phial: the remainder of them floated on the ſurface of the aqueous liquid; and the ether, as well as the aqueous liquid, appeared to be perfectly tranſparent and *colourleſs*.

By the length of time which was required for the ether and the aqueous liquid to ſeparate, I thought I could perceive that the ether had loſt ſomething of its fluidity; but, as this was an event I expected, it is the more likely, on that account, that I was deceived, when I imagined I ſaw proofs of its having taken place.

On removing the cork, after the contents of the bottle had been ſuffered to cool, there was no appearance of any conſiderable quantity of air, or other permanently elaſtic fluid, having been either generated or abſorbed, during the experiment.

Finding that the oxide of gold might be ſo completely and ſo expeditiouſly reduced, by means of ether, I conceived it might be poſſible to perform that chemical proceſs, *in the moiſt way*, by

by means of essential oils; and this conjecture proved to be well founded.

Experiment No. 14. Upon a quantity of a diluted aqueous solution of nitro-muriate of gold, in a small pear-like phial, about 1½ inch in diameter at its bulb, was poured a small quantity of etherial oil of turpentine, just as much as was sufficient to cover the aqueous solution to the height of two-tenths of an inch; and the phial, being well closed with a good cork, well secured, was exposed one hour to the heat of boiling water in a steam-vessel.

The gold was revived, appearing in the form of a splendid pellicle, of a bright gold colour, which floated on the surface of the aqueous liquid. The oil of turpentine, which, at the beginning of the experiment, was as pale and colourless as pure water, had taken a bright yellow hue; and the aqueous fluid, on which it reposed, had entirely lost its yellow colour.

On shaking the phial, its contents were intimately mixed; but, on suffering it to stand quiet, the oil of turpentine soon separated from the aqueous liquid, retaining its bright yellow hue, and leaving the aqueous liquid colourless.

On shaking the phial, *before it had been exposed to the heat*, and mixing its contents, and then suffering it to stand quiet, the oil of turpentine, on taking its place at the top of the aqueous so-

 lution,

lution, was not found to have acquired any colour, nor was the bright gold colour of the solution found to be at all impaired. When sulphuric ether was used, instead of the oil of turpentine, the effect was in this respect very different.

To find out whether the oil of turpentine used in this experiment, and which had acquired a deep yellow colour, had lost that property by which it effected the reduction of the metallic oxide, I now poured an additional quantity of the aqueous solution of the oxide into the phial, and, shaking the phial, exposed it, with its contents, to the heat of boiling water.

After it had been exposed to this heat about two hours, I examined it, and found that though a considerable quantity of gold had been revived, yet the aqueous liquid still retained a faint yellow colour.

The oil of turpentine had acquired a deeper and richer gold colour, approaching to orange.

To the contents of the phial I now added about half as much distilled water, and, mixing the whole by shaking, I exposed the phial again, during two hours, to the heat of boiling water; when the remainder of the oxide was reduced, and the aqueous liquid left perfectly *colourless*.

On repeating this experiment with oil of turpentine, and varying it, by using a solution of the oxide of *silver*, (an aqueous solution of nitrate of

of silver,) instead of that of *gold*, the result was nearly the same. The metal was revived, and the oil of turpentine acquired a faint greenish-yellow colour.

I also revived the oxides of gold and of silver with *oil of olives*, by a similar process, with the heat of boiling water. The oil of olives used in these experiments lost its transparency, and became deeply coloured; that used in the reduction of the oxide of silver, taking a very deep dirty brown colour, approaching to black; and that employed in reducing the oxide of gold, being changed to a yellowish-brown, with a purple hue.

In the experiment with the oxide of silver, the inside of the phial, in the region where the oil reposed on the aqueous solution, was beautifully silvered; the revived metal forming a narrow metallic ring, extending quite round the phial; and, in both experiments, small detached pellicles of revived metal were visible in the oil, and adhered in several places to the inside of the phial, forming bright spots, in which the colour of the metal, and its peculiar splendour, were perfectly conspicuous.

Experiment No. 15. As *carbon* is one of the constituent principles of spirit of wine, as well as of essential oils and sulphuric ether, I thought it possible that I might succeed in the reduction of the

the oxide of gold, by mixing alcohol with an aqueous ſolution of nitro-muriate of gold, and expoſing the mixture, in a phial well cloſed, to the heat of boiling water; but the experiment did not ſucceed.

By pouring upon this mixture a ſmall quantity of oil of olives, and expoſing it again to the heat of boiling water, the gold was revived.

Is it not probable that the reaſon why the oxide was not reduced by alcohol, is the mobility of thoſe elements which ought to act on each other, in order that the effect in queſtion may be produced? I have no doubt but the oxide would be reduced, could the alcohol be made to reſt on the ſurface of the aqueous ſolution, without mixing with it.

I wiſhed to have been able to have collected and examined the elaſtic fluids, which probably were formed in moſt of the preceding experiments; but my time was ſo much taken up with other matters, that I had not leiſure to purſue theſe inveſtigations farther.

In order to ſee what effects would be produced by the heat generated at the ſurface of an opaque body, of a nature different from thoſe hitherto uſed in the reduction of the metallic oxides, and one that is little diſpoſed to form a chemical union with oxygen, *(magneſia alba,)* when, being immerſed in an aqueous ſolution of the oxide of gold,

gold, the rays of the ſun were made to impinge on it, I contrived the following experiment.

Experiment No. 16. I took four ſmall thin phials, A, B, C, and D, of very fine glaſs, and, putting into each of them about five grains of dry *magneſia alba*, I filled the phial A, nearly full, with a ſaturated aqueous ſolution of the oxide of gold.

I filled the phial B, in like manner, with ſome of the ſame ſolution, diluted with an equal quantity of diſtilled water; and the phials C and D were filled with the ſolution ſtill farther diluted.

Theſe phials, open or without ſtoppers, were expoſed one whole day to the action of the direct rays of a bright ſun, their contents being often well mixed together, during that time, by ſhaking.

The contents of all theſe phials changed colour, more or leſs, but they acquired very different hues. The contents of the phial A became of a very deep rich *gold colour*, approaching to *orange*, the earthy ſediment being throughout of the ſame tint.

The contents of the phial B, which were at firſt of a light ſtraw colour, firſt changed to a light green, and then to a greeniſh-blue. The phial having been ſuffered to ſtand quiet ſeveral days, in an uninhabited room, in a retired part of the houſe, the ſolution became nearly colour-

leſs,

lefs, and the fediment was found to be of a dirty olive colour.

The colour of the contents of the phials C and D was changed nearly in the fame manner; and, having been fuffered to ftand quiet two or three days, to fettle, the folution was found to be quite colourlefs, and the fediment to be deeply coloured. There was, however, a very remarkable difference in the hues of the two phials; that of the phial C being of a light greenifh-blue; while that of the phial D was indigo, and of fo deep a tint, that it might have eafily been taken for black.

Thefe appearances were certainly very ftriking, and well calculated to excite my curiofity; but I am fo much engaged in public bufinefs, that it is not at prefent in my power to purfue thefe inquiries farther. I wifh that what I have done may induce others, who have more time to fpare, to devote fome portion of their leifure to thefe interefting inveftigations.

XXXVIII. *Deſcription of a portable Machine for loading and unloading Goods. By Mr.* George Davis, *of Windſor, Berks.*

WITH A PLATE.

From the Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce.

A Premium of Forty Guineas was given to Mr. Davis for this Invention; ſome Account of which is given in the following Letter, which accompanied the Model thereof ſent to the Society.

I HAVE conceived it neceſſary to ſend a framed ſtage, as a repreſentation of a cart, to which the model is fixed on the front. The pullies that are on the ſtage may, for the moſt part, be affixed on the machine itſelf, which is adapted to every direction, and will ſuit all carriages, however built. The model is made on a ſcale of about four inches to a foot, and will raiſe more than five hundred weight; I am therefore certain that the machine, when made of its intended ſize, will be

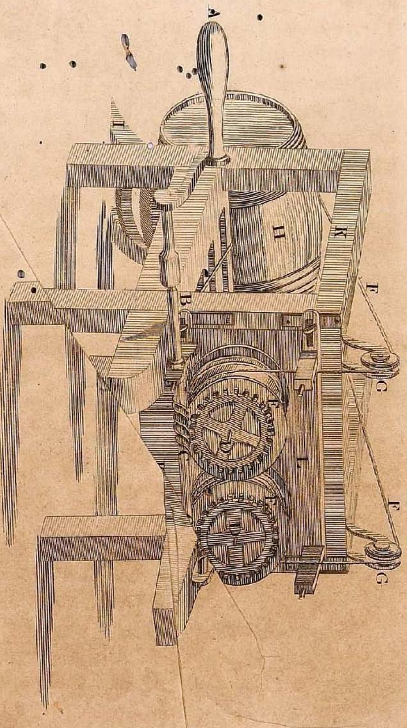
be capable of loading a ton weight, by one man only, and will be fo portable as not to exceed one hundred and twelve pounds in weight.

Reference to the Figure of the Machine. (See Plate XV.)

A, the winch, which turns the bar B. This bar has on it two endlefs fcrews or worms C, C, which work in the toothed wheels D, D. Thefe wheels are fixed to the barrels E, E, round which the ropes F, F, coil, wind up, or let out the fame occafionally; which ropes, paffing over the two pullies G, G, are brought round; and their ends, having hooks for that purpofe, are hitched into ftaples, fixed to the front of the cart, or other carriage: within thefe ropes the load H is placed, on a common pulley I, which forms an inclined plane, up which, by the turning of the winch, the ropes are wound upon the barrels, and the load raifed into the carriage.

K. K. The frame, intended to reprefent the part of the cart, or other carriage, on which the machine is occafionally to be placed.

The whole of the barrels and cogged wheels are contained in an iron box L, the fides of which are reprefented in the figure as taken off, that the conftruction of the feveral parts may be fhewn.


A
I
H
K
F
B
G
E
D
C
L
F
E
D
G

XXXIX. *On the Means of improving the Art of Hat-making.* By M. Chaussier.

FROM THE *JOURNAL POLYTECHNIQUE.*

It is well known that the art of making hats consists in forming, with the wool or hair of various animals, a sort of stuff of a dense compact texture, which is capable of taking, and preserving, any form that is given to it. To bring the stuff to this state, a variety of operations are employed, partly chemical and partly mechanical; they may, however, be reduced to four principal ones, namely, felting, fulling, dying, and stiffening.

I shall not stop to describe the operation of felting, nor the previous preparations required by many kinds of hair, in order that they may be used in hat-making; this would lead me too far from my present purpose, and would be only a repetition of what is already well known to most persons, especially since the publication of the interesting memoir of M. Monge, on this sub-

ject, in the fixth volume of the *Annales de Chimie* *.

I fhall here only obferve, that the workman, by the help of a bow, diftributes, beats, and fpreads equally, in fmall parcels, on a flat furface, the quantity of hair he has felected : this hair he covers with a linen cloth, a little wetted, and then, by the help of a gradual preffure in every direction, he connects the hairs together; which faften to, and entwine with, each other, fo as to form a kind of ftuff, of a foft and fpongy texture. Upon this firft piece of ftuff, the workman applies another, made in the fame manner; fometimes a third, and even a fourth, according to the nature of the hair he makes ufe of, and according to the thicknefs and confiftence he intends to give to his work. He then fucceffively collects thefe different pieces together, difpofing them in the form moft fuitable to the purpofe for which they are intended, and, to make the different pieces cohere, he moves and preffes them gradually and repeatedly in all directions; during which operation, he keeps the ftuff fupple and moift, by fprinkling it flightly with warm water.

The foregoing procefs, which is merely me-

* This memoir of M. Monge is printed in our third volume, page 351.

chanical,

chanical, forms what is called felt *. This is a ſoft ſpongy kind of ſtuff, more or leſs thick; its texture it as yet looſe and imperfect, the hairs of which it is compoſed being ſo weakly connected with each other that it would eaſily diſunite. In order to give it the requiſite degree of denſity and conſiſtence, it muſt undergo the operation of fulling.

The object of the operation ſo called, which is in ſome meaſure the completion of felting, is to connect the hairs more cloſely one with another, to produce a more intimate coheſion of the maſs, and to render it durable. For the above purpoſe, a mere mechanical preſſure is not ſufficient; nothing would be obtained by that but an unequal ſhapeleſs maſs, without conſiſtence; experience has long ſince pointed out, that ſomething more than preſſure is neceſſary. Accordingly, in our manufactories, the workmen

* Felt may be employed for a variety of purpoſes. Some time ago, a perſon ſuppoſed it might be uſed for making ſoles of ſhoes, and made ſeveral pair. They anſwered very well in dry weather; but, notwithſtanding the workman had taken care to put a reſinous ſubſtance between the inner and the outer ſole, they readily abſorbed moiſture, and became heavy and diſagreeable. It may, however, be poſſible, by farther attention to the ſubject, to find the means of making felt more compact, and leſs permeable to moiſture. Such a trial ſeems worthy to be made; for which reaſon I mention it in this note.

employ

employ (for the purpofe of fulling) a water-bath, heated almoft to boiling, and into which are put ten or twelve pounds of lees of wine, to every hundred pounds of water: the fame degree of heat is kept up during the whole operation; and every three or four hours a frefh quantity of lees is added.

The bath being thus prepared, the workmen bring their felt to it, and begin by plunging it into the liquor; they immediately take it out again, and fqueeze it, fold it, roll it, and prefs it in all directions; fometimes with the hand, defended by a leather glove, that it may not be fcalded, fometimes with a roller, or other fimilar inftrument. The immerfion of the felt, and the working of it, are repeated until it is brought into a very compact ftate, and has acquired the requifite degree of confiftence.

Such are the methods followed in manufactories, and the only ones that are pointed out in the *Defcription des Arts*, and in the new edition of the *Encyclopedie Methodique*.

The purpofe of fulling being to form a denfe compact ftuff with hair, and to produce an intimate cohefion of the fibres of which it is compofed, and a mere mechanical operation not being fufficient for this purpofe, even with the affiftance of a water-bath raifed to a boiling heat, unlefs wine-lees are added to the faid bath; it follows,

follows, that the wine-lees may be conſidered as a chemical menſtruum, which acts directly on the ſubſtance of the hairs themſelves, and produces, either by ſoftening or by ſwelling them, a certain alteration, which is neceſſary to bring about the coheſion of the different fibres of which the ſtuff is compoſed. As the lees conſiſt of mucilaginous and colouring parts, diſtinct from thoſe which are mixed with a great quantity of tartar or acidulous tartrite of potaſh, it was of conſequence to aſcertain what was the real active principle in the lees.

The editor of the *Encyclopedie* has poſitively affirmed, that the potaſh of alkaline ſalt, in the lees, is the active principle in the operation of fulling. But, to demonſtrate the error of this aſſertion, nothing more is neceſſary than to dip a piece of blue paper into the bath; the paper will inſtantly be turned red. If, after the bath has been uſed for ſome hours, its power is again examined, it will be found that the tartar it originally contained is in part exhauſted: this circumſtance the workmen are ſenſible of, from the difficulty they find in continuing their work, and a freſh quantity of wine-lees becomes neceſſary. Beſides, if we recollect how ſmall a proportion of tartar is ſoluble in cold water, we ſhall eaſily perceive why it is neceſſary, in this operation, to keep the water almoſt boiling: it is evident,

therefore,

therefore, that the lees act by the portion of tartar they contain.

This first observation led me to conjecture, that sulphuric acid might perhaps be advantageously made use of, in the place of wine-lees. Twelve pounds of lees are usually allowed to every hundred pounds of water: I estimated that one drachm of sulphuric acid would be at least equal to one pound of lees, and, consequently, that one ounce and a half of sulphuric acid would be sufficient for one hundred pounds of water. My conjecture was soon confirmed by experience; and, after a first trial, which the manufacturer was with great difficulty persuaded to venture upon, it was ascertained that the use of sulphuric acid was very much preferable to that of wine-lees, being not only more œconomical, but also rendering the operation of fulling more easy; and, what is a circumstance of still greater consequence, the health of the workman is not injured by the great and continued degree of heat; or by the thick vapours and nauseous smell which exhale from the bath, particularly when the lees happen to be mouldy or putrid, as is frequently the case with those which are used in these manufactories *.

In

* I cannot help mentioning a small inconvenience that happened, the first time sulphuric acid was made use of. The

In fact, when ſulphuric acid is made uſe of, it is not neceſſary (as it was when wine-lees were uſed) to keep the water of the bath nearly boiling. A heat of ninety, or at moſt of one hundred degrees, of Fahrenheit, is ſufficient for good fulling. The ſaving of fuel is an object of conſequence in manufactories; and as, when ſulphuric acid is employed, very little fire is neceſſary, leaden veſſels may conveniently be uſed for the bath, inſtead of copper caldrons, the firſt coſt and annual repair of which are both very expenſive.

The felts prepared by this new proceſs are alſo greatly ſuperior to thoſe prepared in the old way, in a bath made with wine-lees. In fact, the mucilaginous and colouring particles of the lees, which are ſuſpended in the bath, make their way into the ſubſtance of the ſtuff, and adhere thereto more or leſs forcibly; and, when the hats, after having been dyed, are beaten or

The quantity of acid requiſite for the bath was put into a bottle; and, being careleſſly poured into the bath, while the bottle was held pretty high, ſome drops eſcaped, and fell upon the cloathes and hands of the operator, occaſioning ſpots, and even corroſion. A ſimilar accident may be eaſily avoided, by plunging the bottle into the bath, and pouring out its contents in ſuch a way that no part of them be ſcattered.

bruſhed, a great quantity of a very fine black powder flies from them; which not only weakens the texture of the felt, but alſo floats about the workſhop, very much incommoding the workmen, and often occaſioning coughs and ſore throats.

For theſe reaſons, the manufacturer who firſt made trial of this method continues to uſe it, in preference to the old one; and, according to his own account, he finds infinite advantages therein. In one of his letters to me, he thus expreſſes himſelf: "Hats prepared in this manner are not "only free from the duſt with which the others "are loaded, but they alſo take the dye better, "and are cleaner. The workman uſes a bath "which is leſs hot; a circumſtance that is more "convenient to him, and ſaves fuel to the manufacturer."

Laſtly, beſides theſe advantages, the wine-lees, which are now made uſe of by the hatters in large quantities, will remain for other purpoſes. From them may be advantageouſly procured alkaline ſalt, for making ſaltpetre, ſoft ſoap, and various other articles.

When I had aſcertained that the fulling of hats was brought about chiefly by the portion of acid which exiſts in the lees, I determined to uſe ſulphuric acid (oil of vitriol) inſtead of them, becauſe

because it is always to be procured in the ſhops, and at a reaſonable price *.

But, although all the acids have certain properties in common, by which they reſemble each other, they have alſo peculiarities which render them perfectly diſtinct. It would therefore be worth while to examine, whether ſome one of the numerous claſs of acids might not have a more immediate action upon the ſtuff than others, ſo as to ſhorten the operation of fulling, without rendering it more expenſive, or injuring the texture of the ſtuff. Might not acid liquors be prepared, by the fermentation of barley, or of bran, or of ſome ſimilar ſubſtance, in the manufactory itſelf. This is an object of enquiry worthy the attention of manufacturers, and of all who love and cultivate the arts.

I ſhall not give a particular account of the proceſs of dying. In the manufactory of the *Cote d'Or*, they no longer uſe galls; oak-bark being advantageouſly uſed inſtead thereof.

* Sulphuric acid, more or leſs diluted with water, might be advantageouſly made uſe of in many of the arts. For inſtance, braziers uſually employ wine-lees for cleaning and brightening their work: they would ſurely obtain the ſame effects, by plunging it into water ſlightly acidulated with ſulphuric acid; and they would not then be obliged to rub their work for ſo long a time as when they make uſe of lees.

I ſhall now proceed to the fourth and laſt operation of hat-making; namely, ſtiffening.

This operation conſiſts in applying, to the inner ſurface of the crown and brim of the hat, a glutinous ſubſtance, which, in drying, renders the work firm, and enables it to keep the form which has been given to it. The compoſition uſually employed for this purpoſe, conſiſts of gum arabic, common gum of this country, and Flanders glue, diſſolved together in a ſufficient quantity of water, and reduced, by boiling, to a proper conſiſtence.

This preparation, ſimple and trifling as it appears, is not a matter of indifference, with reſpect to the beauty and duration of the work. If it be too tenacious, it renders the ſtuff dry and brittle; and, when the hat has been uſed ſome months, there is formed upon its ſurface a kind of greyiſh cruſt, which injures its texture. It appeared to us, that the quantity of gum arabic which is added to the glue, was the principal cauſe of this inconvenience, and we therefore ſought, among the plants of this country, for ſome ſimple preparation, which might be uſed, inſtead of theſe natural and brittle gums from foreign parts. Mucilage is found in great quantity in many plants; it may eaſily be extracted by boiling; and a factitious gum, which is both ſupple and tenacious, may be formed by evaporation. Theſe conſiderations

rations led me to recommend, for the purpoſe of ſtiffening, a ſolution of glue, in a ſtrong and mucilaginous decoction of linſeed. This preparation has been long uſed in the manufactory, and is both more œconomical and more conducive to the beauty of the work.

Since that time, M. Margeron having communicated to me ſome obſervations reſpecting the mucilage which may be extracted from the leaves of the horſe-cheſnut tree, and having aſcertained how great a quantity of mucilaginous and glutinous matter theſe leaves furniſh, (eſpecially when the foliation is in full vigour,) a ſolution of glue, in a ſtrong decoction of them, has been uſed, with great ſucceſs, for the purpoſe of ſtiffening.

There are many other indigenous plants from which factitious gums might be obtained with equal eaſe. We are at preſent employed in an enquiry upon this ſubject; and we hope to be able, ſome time hence, to preſent to the public the reſult of our reſearches.

P. S. Since the above memoir was written, a lover of the arts, who has had great opportunities for obſervation, informed me that oil of vitriol is uſed, in the fulling of hats, in ſome foreign manufactories, where they make a great ſecret of the proceſs. I was ignorant of it; the books I have looked over do not mention it; and the manufacturers I have conſulted knew nothing of it.

XL.

XL. *Account of a Method of encreasing the Force of Gunpowder.* By DOMINICK VANDELLI, *Professor of Natural History and Chemistry in the University of Coimbra.*

From the MEMOIRS of the ACADEMY of SCIENCES of LISBON.

AFTER having purified nitre, according to the method lately discovered, so as to render it intirely free from sea-salt, I dissolved it in water impregnated with inflammable gas, which gas I had obtained from the decomposition of water, by evaporating or distilling water in greater quantity than is necessary for its total decomposition. With this solution of nitre, I moistened the mixture of sulphur and charcoal; and continued the process of making gunpowder in the usual manner.

By the above means, I obtained a species of gunpowder, which very much surpassed in force all kinds of gunpowder hitherto known.

The above discovery is announced in the same vague and unsatisfactory manner as that of fixing mercury, by the same author, of which we gave an account in our last volume, page 59; but, as the subject is interesting, and the experiment easily repeated, we thought right to insert it.

XLI.

XLI. *List of Patents for Inventions, &c.*

(Continued from Page 216.)

EDMUND THOMASON, of Birmingham, in the county of Warwick, Button-maker; for improvements in making steps for coaches, &c. and all kinds of carriages to which steps are used. Dated December 22, 1798.

THOMAS OVEY, of Fleet-street, London, Hatter, and JOHN JEPSON, of Duke-street, Southwark, Hat-manufacturer; for a method of manufacturing hats. Dated December 24, 1798.

JAMES FUSSELL, of Mells, in the county of Somerset, Iron-manufacturer; for a balance-engine, or apparatus for raising and lowering boats, barges, or troughs, at the locks or falls on inland canals. Dated December 24, 1798.

WILLIAM ALISON, of Long-lane, in the parish of Bermondsey, Surrey, Tanner; for manufacturing an article into leather, commonly called Spanish or Morocco leather. Dated January 4, 1799.

JOHN KENT, of Southampton, Architect and Builder; for a method of applying power to the working

working of mills, and other machinery where power is required. Dated January 5, 1799.

James Edgell, of Frome Selwood, in the county of Somerſet, Gentleman; for the uſe and application of metal, of a peculiar quality, and great ſtrength, in the place of common iron, in all caſes where common iron hath hitherto been employed. Dated January 1[illegible] 1799.

William Fitzgerald, late of the Temple, London, Eſquire; for a ſignal-trumpet, for increaſing the powers of ſound, by ſea and land. Dated January 23, 1799.

Cater Rand, of Lewes, in the county of Suſſex, Eſquire; for an improved military and naval teleſcope. Dated January 26, 1799.

Thomas Cooke, of Red-lion-ſquare, Holborn, Clerk; for an apparatus which he calls *Carbo frugaliſt*, being an effectual mode of applying fire to boilers, ovens, and other caldronic implements. Dated January 29, 1799.

Joseph Barton, of Old-ſtreet, in the pariſh of St. Luke, Chemiſt; for a medicine, which he denominates *Compound concentrated fluid vital air*, of great uſe in the cure of putrid diſeaſes, &c. and another preparation, which he calls *Aerated preventive fluid*, as preventive from putrid infection, &c. alſo, *Aerated liquid balm*, for preſerving and beautifying the ſkin. Dated January 29, 1799.

Printed by Nichols *and* Son,
Red Lion Paſſage, Fleet Street.

REPERTORY OF ARTS AND MANUFACTURES.

NUMBER LIX.

XLII. *Specification of the Patent granted to Mr.* WILLIAM PONTIFEX, *of Shoe-lane, in the City of London, Copperſmith, (with the Aſſiſtance of his Brother); for an improved Still-head, for diſtilling all Sorts of Liquor.*

WITH A PLATE.

Dated Dec. 19, 1798.

TO all to whom theſe preſents ſhall come, &c. Now KNOW YE, that I the ſaid William Pontifex, in purſuance of the directions contained in the ſaid letters patent, by this preſent deed or inſtrument, under my hand and ſeal, do deſcribe and aſcertain my ſaid invention, and the manner in which the ſame is to be performed, in manner following; that is to ſay:

 Fig.

Fig. 1. (Plate XVI.) ſhews the improved patent ſtill-head, when compleat. A A A A, ſhews the back, made with copper, or other materials, ſufficiently large for the whole head and neck to be covered with water, for the purpoſe of condenſing the ſteam between the two heads. B, ſhews the crown of the external head, with loops to raiſe the ſame. C, ſhews the ſtuffing-box, through which the ſpindle muſt come, to work the chains, if made for a waſh-ſtill. D, ſhews the pipe to take away the waſte or hot water from the back, between the two heads, and diſcharge at the pipe E. F, ſhews the pipe to take away the ſpirit (into the worm) that is condenſed between the two heads. G, ſhews the pipe or neck that carries the uncondenſed ſteam into the worm. H, the large end of the neck, ſoldered to the external head.

Fig. 2. ſhews the back by itſelf, made with copper, or other materials, to hold water for condenſing the ſteam immediately, as it comes between the external and internal heads. A, ſhews the collar, where Fig. 3. is to be placed.

Fig. 3. ſhews the external head, with neck, loops, ſtuffing-box, *&c.* compleat, to be placed in the centre of the back, (ſhewn by A, in Fig. 2.) by nails, ſolder, or other means.

Fig. 4. ſhews the internal head, compleat, to be placed by ſolder, or other means, to the inſide of the collar of the external head. A, ſhews the

the ſides, with holes, as deſcribed by the black marks. B, the part of the crown made faſt, projecting over the ſides four inches. C, the centre part of the crown, ſupported by four bearers, ſix inches above the other part: the dark mark, under this part, ſhews the paſſage for the ſteam; this part alſo projects over the open part four inches; the dark ſpot in the centre for the ſpindle to go through, to work the chains.

Fig. 5. ſhews a courſe of copper, with a tube, to be placed, with ſolder, or other means, between the two heads; the bottom edge ſoldered to the external head, near the collar; the top edge ſoldered to the internal head, to form a paſſage for water between the two heads. A, ſhews the tube or pipe to convey the waſte or hot liquor, through the external head, into the paſſage between the two heads, and diſcharge itſelf in a convenient part.

The principal advantages ariſing from the patent improved ſtill-head, conſiſt in the peculiar formation of an internal head, made round, or otherwiſe, as ſhewn in the drawing by Fig. 4, and made on a ſcale of half an inch to each foot of the real ſize of the ſtill-head; with proper paſſages to admit the ſteam between the two heads, and, when condenſed, ſo formed as to prevent the ſmalleſt quantity of ſpirit falling again into the ſtill; by theſe means, the condenſation is ſo

 rapid,

rapid, that the buſineſs may be done within half the uſual time, and ſave one-third of the fuel in general conſumed.

Another advantage ariſes from the formation of a paſſage, for the waſte or hot liquor to paſs round the outſide of the collar of the internal head, on the ſolder which faſtens the two heads together, to prevent the ſpirit gaining heat by the riſing ſteam through the collar into the head; this is done by a courſe of copper, or other materials, as ſhewn by Fig. 5, ſoldered, or otherwiſe, to the extremity of the outſide head, at the bottom part, near the collar, and brought tapering to the internal head, and ſoldered, or otherwiſe. This courſe, in the head, as repreſented in the drawing, muſt be about one foot ſix inches deep; at the bottom of this courſe is a pipe, brought through the external head, to take the ſpirit into a convenient part of the worm.

Another advantage, in this improvement, is the having a ſupply of hot liquor, near boiling.

A farther advantage conſiſts in the forming a back with copper, or other materials, ſufficient to cover the head and neck with water; whereby moſt part of the ſpirit is condenſed between the two heads, and, if any is not condenſed, it runs down the neck into the worm. In witneſs whereof, &c.

Fig. 4.

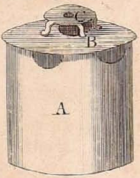


Fig. 3.

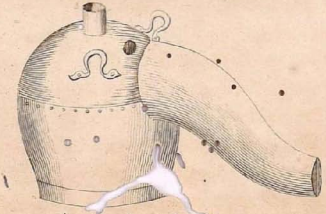


Fig. 5.

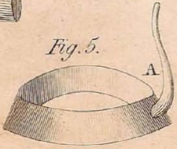


Fig. 1.

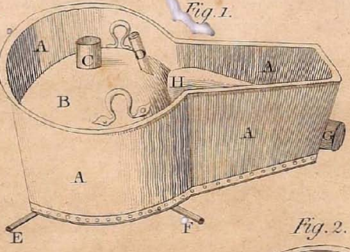
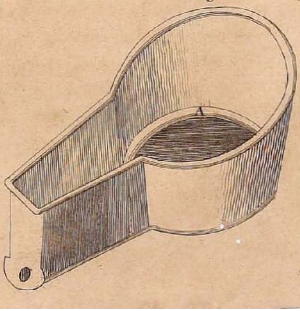


Fig. 2.



XLIII. *Continuation of the Specification of Mr.* BENTHAM'S *Patent for various new and improved Methods of working Wood, Metal, and other Materials.*

(From Page 249.)

V. *WORKING by a rotative motion of the tool.* In the inſtance of circular ſaws, not to mention boring and grinding tools, working by a rotative motion has already been uſed, as I underſtand, in a few inſtances, ſuch as, cutting timber into boards, croſs cutting logs for fire-wood, cutting mortiſes for ſhips' blocks, cutting the teeth of cog-wheels, and other ſlight indentures in metal. But the idea of adapting the rotative motion of a tool, with more or leſs advantage, to giving all ſorts of ſubſtances any ſhape that can be required, is my own, and, as I believe, intirely new; I place it, accordingly, amongſt the inventions of which I claim the excluſive property, in as far as it has not yet been reduced to practice by others, and in as far as the contrivances here deſcribed afford ſufficient inſtruction for producing the effect. To take the ſimpleſt mode of fitting

fitting up a circular ſaw, for cutting in this way, conceive a ſpindle, furniſhed with a circular ſaw, turning between two centres, as if in an ordinary turning lathe, with a rigger or pulley to receive a band. Let the ſaw be ſtrengthened, and confined to its poſition, by two flanches, one on each ſide of it, of equal diameter one to the other: as this diameter limits the depth of the cut which can be given by the ſaw, it ſhould therefore be no greater than what is neceſſary to give the ſaw the neceſſary degree of ſtiffneſs. Immediately over the ſpindle fix a bench, of a ſize adapted to the ſupport of the work you have to perform, and croſſing the ſpindle at right angles. In this bench make a ſlit, for the ſaw to play in, projecting above it, more or leſs, according to the depth of the piece which it has to cut. Standing now in the direction of the ſaw, put it in motion, in ſuch a manner as to make the upper part move towards you, as it turns, ſhoving the piece on againſt the ſaw, it will be cut through. Where a rigger, if ſmall enough not to come in the way of the piece, would be too ſmall to give motion to the ſaw, its office may be performed by a cog-wheel, of ſomewhat leſs diameter than the flanches; to which cog-wheel you may give motion by another cog-wheel, fixed to a rigger of a larger ſize, turning upon a ſeparate ſpindle.

How,

How, by means of a rotative ſaw, to ſhape a piece from the rough: a piece of wood, for example, in the ſtate of a log, or a ſmall branch of a tree; or a piece of metal, as it comes from the crucible or the forge. 1. The firſt thing to be done is to give it a ſtraight ſide: for this purpoſe, the buſineſs is, to advance the piece, in a direction exactly ſtraight, againſt the ſaw. For ſecuring this ſtraightneſs, more methods may be employed than one: the following I have found as commodious as any. Cut in the bench a longitudinal channel, in a direction parallel to the ſaw, and the nearer to it the better. Into this channel or groove inſert a bar or tongue, ſo as to fit exactly, and yet ſlide with eaſe, but without projecting above the bench. On this longitudinal bar fix two tranſverſe bars, projecting their whole thickneſs above the bench; one of them fixed, and the other movable, ſo as to be fixed at different diſtances from the former, the diſtance being adjuſtable to the length of the piece which is held between them. Of theſe tranſverſe bars, the foremoſt, it is evident, cannot, at that end of it which points to the ſaw, extend beyond the ſaw; ſince, if it did, it would be cut off by it: the hinder may, or may not, according as the purpoſe requires or not, that it ſhould paſs the ſaw. The longitudinal bar, thus furniſhed with the two tranſverſe ones, forms what I term the

ſlider.

ſlider. To diminiſh the friction, between this bed and the bench or floor on which it ſlides, friction rollers may of courſe be applied, and that either to the bench or to the bed. To this ſlider make faſt the rough piece, by any means, and ſo ſhove it along, from end to end, againſt the ſaw; the conſequence is, that if the ſaw be deep enough, either the piece will be ſimply cut to an even ſurface on one ſide, or it will be cut into two diſtinct pieces, each having one ſuch even or flat ſide. Fix now one of theſe pieces on the ſlider, with the flat ſide downwards; ſhove it againſt the ſaw as before, and, in this manner, this piece will acquire a ſecond ſmooth ſide, contiguous to the former, or be cut into two other pieces, each having two ſuch contiguous ſmooth ſides. The angle formed by theſe two contiguous ſides will be a right angle, while the upper ſurface of the bench is parallel with the ſaw-ſpindle; but, if it be required to give the piece any bevelling, this may be done by making the bench to turn or tilt on pins or gudgeons, like that above deſcribed for cutting to any bevelling by up-and-down ſaws; or the ſaw-ſpindle may be made to tilt, the bench remaining fixt; or, the bench and ſpindle remaining as before, the piece itſelf may be tilted, and confined to the ſlider, ſo as to meet the ſaw at the angle required. Pieces of any figure, by being confined to this ſlider by ſtops and ſupports,

may be cut lengthwife, or tranfverfely, to any angle or length. In fpeaking of cutting from the rough, we fhewed how to give a piece two ftraight fides; as to the remaining fides, though the piece might be fixed to the flides again, yet, to fave the time that might be confumed, in adjufting and confining the piece according to the dimenfions required, the following method may be employed: let a bar of wood, or metal, which we will call a guide, be applied to the bench, longitudinally, in a direction exactly parallel to the faw, and (as in general it will be more convenient) not on the fame fide as the flider is. This guide fhould move fo as to be fet at different diftances from the faw, preferving always its parallelifm with refpect to the faw. If the piece to be cut be applied with one of its flat fides lying on the bench, and another preffed flat againft this guide, advance it now againft the faw, and fo much as extends beyond the faw will be cut off, and thus another flat fide will be given to the piece, and fo on, for any other fide or fides: the diftance of this guide from the faw will, it is evident, give the thicknefs or breadth of the piece to be cut, and, the fame diftance being preferved, any number of pieces may be cut exactly to the fame thicknefs or breadth.

To cut a piece taper or wedge-fafhion, provide a wedge of the degree of taper required; apply

this wedge to the longitudinal guide; then, applying the piece to the other ſide of the wedge, ſhove up piece and wedge together, as you would the piece alone to cut it parallel-wiſe: this contrivance may equally be applied to the up-and-down ſaw. Where a very thin ſaw is employed in roughing out a piece, there is a caſe in which its thinneſs, though ſupported by guides, like thoſe to the up-and-down ſaw, might render its work leſs true; that is, where the quantity of matter it has to detach in different parts is ſo unequal, as that, on one ſide having here and there nothing to cut off, it would be thrown off to that ſide, and bent out of its courſe, by the inequality of reſiſtance. To obviate this danger, the flanch on that ſide may be made to extend nearly to the root of the teeth; at which place it ſhould be chamfered off to nothing, ſo as, by the inclination of its ſurface, to wedge off as it were, and ſo bend or break, whatever it finds on that ſide. Where the diameter of ſuch a ſaw is conſiderable, the ſaw, inſtead of being of one piece, may be more advantageouſly compoſed of annular ſegments faſtened on the face of the flanch.

To make, in any piece, a cut of a given depth, which ſhall not go through, and which I call a ſcore, you have only to adjuſt to the depth required, the height to which the ſaw, through its ſlit, projects above the bench; which is done by

making

making either the bench or the ſpindle ſo as to riſe or lower at pleaſure. If, after having given any ſuch cut, which does not go through the piece, you turn the piece, ſo as to give it another cut, meeting and making an angle with the former cut, you may thus cut out a portion of the piece altogether, leaving in it the ſort of channel which is called a rabbet: by cutting out, on different ſides, two ſuch rabbets, you may leave between them a projecting part, ſuch as is called a tongue; and a tenon is, at the end of a piece, the ſame thing as a tongue on the ſide.

To cut a parallel ſliding groove or channel, you have only to make the circular ſaw, or (to uſe the name I call the tool by, wherever its effect depends upon a degree of thickneſs greater than neceſſary to give it ſtrength) the circular cutter, of the thickneſs requiſite to form the breadth of the groove; the depth being determined, as before, by the height of ſo much of the cutter as projects above the bench. If the groove is to be dovetailed, the cutter muſt be conical at its circumference, that is, the cutter, inſtead of being ſquare at its edge, muſt bevel according to the angle of the dovetail; and the bench, or the ſpindle, muſt be inclined; or the piece ſo ſupported, as that its under ſurface ſhall be parallel to the outer edge or circumference of the cutter. If the piece be now advanced againſt the cutter, one

ſide of the dovetail groove will be formed: to form the other, the piece muſt be reverſed, end for end, and ſhoved along as before. Another mode of cutting out dovetail grooves, may be by a mandril, turning in a collar, and at the end of it furniſhed with a conical cutter, the diameter of which, at the fartheſt end, ſhall be equal to the breadth of the dovetail, and the ſides beveling according to the angle of the dovetail: ſuppoſe the mandril to be placed perpendicularly, for example, in which caſe, the cutter itſelf will be horizontal, with its baſe parallel to the bench; let that end of the mandril at which the cutter is be uppermoſt, the mandril being let through, and the cutter projecting above the bench, and raiſed to ſuch a height above it as the depth of the dovetail channel to be made requires: the piece now lying flat on the bench, advance it againſt the cutter, and a dovetail channel will be cut at one operation. It is evident that in this way, whatever be the breadth and length of the groove or channel to be cut in a piece, ſo much of the ſtuff by the removal of which the channel is formed is conſumed; and, the broader the channel, the greater the reſiſtance the cutter meets with, and the greater the force which is required to make it act. To ſave as much as may be of this force, will be an object in every caſe; and ſo it will be to ſave the ſtuff, where it is of a dear

dear ſort, and the breadth of the required channel conſiderable. To effect both theſe ſavings, inſtead of a thick conical cutter, put on the ſame mandril a thin ſaw, forming the baſe only of the cone. To this thin ſaw there muſt of courſe be a mandril, for it to turn upon; which mandril muſt have ſome means of making its way through the piece, along with the ſaw itſelf, which is mounted on it. This paſſage may be made by either of two expedients: one is, to give to ſo much of the length of the mandril as enters the wood, a power of making its way through, for inſtance, by fluting or forming it into ſharp leaves, and thus making it into a cutter in that part; the other expedient is, by a previous operation to form, for the reception of the mandril, a preparatory groove: it is evident that, the narrower this preparatory groove or channel, the greater the ſaving will be in point of ſtuff, and in point of force; on the other hand, the narrower it is, the weaker the mandril, and the greater the danger of its not being ſtrong and ſtiff enough to ſupport the ſaw which turns on it. To obviate this danger, the mandril may be ſupported by a bar of metal, which, by a perforation, tranſverſe in reſpect to the length of the bar, encloſes the mandril up to the very ſaw, and thus forms a continuation of the collar: this bar may be of any length, provided only that its thickneſs and direction

rection admit of its being received into the preparatory groove, as the piece is advanced againſt the ſaw. The bottom of the groove or channel thus being cut, the ſaw-kerf forming the ſides of it may now be made according to the angle required, and two bars or ſlips will have been cut out intire, one on each ſide of the preparatory groove; or theſe two ſide cuts might have been made at the ſame time with the middle or preparatory one. A ſaw or cutter working in this manner, at the end of a mandril, within the ſubſtance of a piece, may be called a *root-cutter:* by a root-cutter of this ſort, a T-ſhaped channel, uſed in ſome caſes, particularly in metal, inſtead of a dovetail groove, may in this manner be formed at once.

Cutting of mouldings. If the circumference of a circular cutter be formed to the ſhape of any moulding and projecting above the bench no more than neceſſary, the piece, by being ſhoved over the cutter, will thus be cut to a moulding correſponding to that of the cutter, that is, the reverſe of it, juſt as a plane iron cuts its reverſe; accordingly, teeth of ſuch cutters may be conſidered as ſo many plane irons. If a plain cutter, ſuch as that above ſpoken of for cutting a groove in the breadth of a piece, be made ſo thick, or as we might be apt now to ſay, ſo broad, or ſo long, as to cover the whole breadth of the piece,

it will preſent the idea of a roller, I accordingly call it, in this caſe, a *cutting-roller:* it may be employed, and in many caſes with great advantage, to perform the office of a plane. The recollection of what has been ſaid of the manner of producing a waving or winding ſurface, by a rectilineal reciprocating ſaw, may be ſufficient to ſuggeſt the means by which ſimilar effects may be produced, in much greater variety, by a rotary cutter, broad or narrow, plain or formed to a moulding. I ſhall ſpeak only of the cutting-roller; it will be eaſy to apply the obſervations to the other caſes. If a roller of this ſort be placed with its axis horizontal, and the bench underneath it be made to riſe and lower, the bench may be very readily adjuſted, ſo as to determine the thickneſs to which a piece will be reduced by being paſſed under the roller. It is to be obſerved, that where the track of the piece is under the roller, the influence of the rotation, on the advancement of the piece, is the reverſe of what it is where the track of the piece is above the roller; therefore, if you chooſe that the advancement of the piece ſhould, inſtead of being performed in a direction the ſame with that of the rotation, be performed in the oppoſite direction, the direction of the rotation muſt be reverſed. Whether the axis of the roller be horizontal, perpendicular, or oblique, the piece,

piece, by being paſſed againſt it, ſo as to receive its figure, may be made to receive not only a flat and even ſurface, but any longitudinal curvature or waving, by a compound motion; the bench, during the advancement of the piece, approaching and receding from the cutter; and, by giving at the ſame time a tilt to the bench, or to the roller, any degree of winding may be given to the ſurface of the piece. To gain time, cutters may be applied to different ſides of a piece at once; and ſuch of them as make parallel cuts may be mounted on the ſame ſpindle: if the cuts meet, a piece of given depth may be ſlit by cutters of but half the diameter that would otherwiſe be neceſſary.

Formation of ſaws and other cutters, to work with a rotative motion. The moſt obvious mode is, the making the cutter of one piece, conſiſting of ſteel, or iron with ſteel welded on to it, as far as it is neceſſary for ſtrength and ſharpneſs. In ſome inſtances, however, there may be an advantage in making it in pieces, for inſtance, in annular ſegments, faſtened to an included cylinder: the larger it is, the greater will be the advantage in thus compoſing it; and, if a part only is worn out, or damaged, that part may be replaced, without injury to the reſt. Another mode of compoſition is, to make the teeth diſtinct from each other, as well as from the cylinder from which

which they are to project: they will thus be separately bedded in the cylinder, taking on and off, as occaſion may require. This is a mode I have practiſed with particular advantage, in the inſtance of the moulding cutter, and the planing roller, above ſpoken of. For the conſtruction of borers, ſee the article of boring.

Boring; and, in the firſt place, boring to any angle, i. e. *ſo as that the axis of the hole, made by boring, ſhall make an angle with the ſurface at which it commences.* Provide a mandril-lathe, with different borers fitting into it. In a line with the mandril ſtation a bench, capable of being raiſed or lowered at pleaſure: on this bench fix the piece, with ſtops and ſupports, in ſuch a manner as to preſent to the borer the part to be bored, and that in the direction correſponding to the required angle. For the borer to perform its office, the mandril may be made to ſlide to and from the bench; or, on the bench may be adjuſted a *ſliding-bed*, on which the piece being held may ſlide to and from the borer. A new kind of borer, which I make uſe of, conſiſts of a tube of metal, open at the hinder end; the cutting end differently ſhaped, according to the work it has to do, for example, like an auger-bit, centre-bit, gimlet-bit, &c. The reaſon of leaving it open at the hinder end is, that it may afford paſſage to the chips; for which reaſon alſo, if it

be put to a mandril, the mandril muſt be a hollow one; ſo, if the mandril be turned by a handle, the handle can only embrace the outſide of the tube. One advantage of this ſort of borer is, that having no ſhank or ſtem, to obſtruct the paſſage of the chips, it may go through the piece, without being repeatedly drawn out, as an auger or gimlet is, every time the pod is full of chips, for the purpoſe of clearing it. Another advantage is, that as it has a ſmooth cylindrical outſide, it is eaſy to apply bearings of any kind, or even the hand, to guide it at its firſt entrance, and it will continue, throughout its courſe, to turn ſmoothly in the hole it has made. The cutting parts, it is moſt convenient to make ſeparate; and ſo to take on and off, for the purpoſe of being ſharpened, and replaced, when damaged, as well as that different kinds may be applied to the ſame tube or ſtock, according to the different ſorts of work. The tube itſelf ſhould of courſe be as thin as it can be made, conſiſtently with a ſufficient degree of ſtrength; and the cutting parts ſhould expand as it were a little beyond the tube, to clear it for a ſufficient paſſage enucleative, or core extractive.

Boring, ſo as to bring out intirely a nucleus or core. This, when compared with boring in the ordinary mode, is nothing but making an annular groove, inſtead of a cylindrical hole. For ſmall depths,

depths, the properest instrument, as being the simplest, is a kind of plough iron, which I call a *circumambient bit*, turning so as that its cutting end shall describe a circle: of this bit, the edge must of course be adapted to the breadth, and the stem to the curvature, which it is designed the annular channel shall assume; and, for the better discharge of the abraded matter, without the necessity of drawing out the tool from time to time, this stem may be twisted or inclined spiral-wise, so as to worm out the abraded matter as fast as formed. For greater depths, for which the simple tool above described would be too weak, it may be necessary that the stem should be an intire tube. This tube, that it may occupy as little of the breadth of the channel, and thereby afford as little obstruction to the discharge of the abraded matter, as possible, should however be as thin as can be made, consistently with the necessary degree of strength. The edge of the cutter, to which this tube serves as a support, should be of a sufficient breadth, not only to make way for the introduction and advancement of the tube, but to render the channel so much broader, as that there shall be vacant space enough in it to receive the abraded matter, as fast as it is detached. This extra breadth should extend, not withinside, but wholly on the outside of the tube; since an equal breadth on the inside would

 not

not contain ſo great a ſpace. To effect the diſcharge of the abraded matter, one mode is, ſo to form the cutting edge, as that the abraded matter ſhall aſſume the form of a ſhaving, which, being leſs in thickneſs than the breadth of the vacant part of the channel, ſhall, as ſoon as formed, be turned or twiſted a little; ſo that, by lying edgeways, and in the direction, not of a ſemi-diameter of a ring, but of a chord of it, it may find ſufficient room to paſs. Another mode is, to furniſh the end of the tube with two or more ſuch cutters, inſtead of one; and theſe ſo ſhaped and diſpoſed, as to cut each of them a portion of the channel left vacant by the thinneſs of the tube: a borer of this kind I have ſeen applied to the boring of water-pipes. In either caſe, inſtead of a cutter or cutters, the end of the tube itſelf may be cut into teeth like a ſaw; and thoſe teeth diſpoſed into two or more concentric rows, of which the outer one ſhall overhang the thickneſs of the tube. To worm out the abraded matter, wind about the tube a ſpiral riband, which, that it may leave no part of the channel unſwept, ſhould be of ſufficient thickneſs to fill up intirely, as far as the breadth of the riband extends; in the ſame view, it ſhould, at the interior end of the tube, commence as near as poſſible to the cutting part. Should the abraded matter be diſpoſed, by the nature of the material, to ſtick to the

the tube, its extrufion may be infured by a feparate fpiral riband, wound round the tube as before, and advancing with it, but not attached to it, or turning with it; it may either not turn at all, or be made to rotate in the direction oppofite to that of the tube; thus will the whole bufinefs be compleated, where the borer is to be of the perforating or pervious kind, that is; when the excavation is to go through. Where the bore is to be of the impervious kind, there remains to be made the tranfverfe incifion, at the bottom of the channel, for the extirpation of the core. For this purpofe, the tube muft be furnifhed with a cutter or cutters, made fo as to clofe in upon the core, approaching nearer and nearer to the centre, as the tube works round, till they have got fo near, and weakened the core fo much at the root, as to enable it to be broken off. Suppofe a fingle cutter: in this cafe, although, if the depth to be given to the bore be confiderable, this cutter muft, for the fake of ftrength, be fupported by a tube, yet it muft project beyond it, on a ftem; which ftem may be of the fame thicknefs with the tube, but muft be of a breadth not too great to prevent it from being made to bend inwards toward the axis, according to the required angle, that is, the required degree of fuddennefs in the bend. To reconcile the better, the requifite flexibility in the one direction, with the requifite inflexibility

flexibility in the other, the ſtem of this cutter may be made in joints, curving inwards in a longitudinal direction, but inflexible in a lateral direction. When the ſtem of the cutter is in one piece, and not in joints, to favour this centripetal inflection, not only the cutting edge may curve that way, but the ſtem of the cutter may be ſo contracted as to have a tendency to ſpring inwards. When this cutter is in joints, the incurvation muſt be given by a ſeparate ſpring, placed on the outſide of the cutter, and reflected upon it by the re-action of the concave ſide of the excavated channel: when once the courſe of the tool has received an inclination inwards, that inclination, be it ever ſo ſlight, will, by the advancement of the tube, be continued till the extirpation is performed. If the diameter of the core be very conſiderable, in which caſe, the ſtem of the cutter projecting beyond the tube muſt be proportionably long, a ſort of ſtrengthening brace may be applied to it. This ſtrengthening brace may conſiſt of a ſlight chain, attached at one end to the anterior end of the tube, at ſuch a diſtance from the root of the cutter as ſhall be found convenient. Where the nucleus, when bored out, will not drop out of the borer of itſelf, an expeditious mode of clearing the borer of the nucleus may be an object of importance: this will be more particularly apt to be the caſe, where, on ac-

count

count of the yielding of the ſubſtance, or the thinneſs of it, the boring may be performed by the mere ſharpneſs of the tool, without the neceſſity of its working a paſſage for itſelf by abraſure. For effecting the diſcharge at the poſterior end of the boring tube, the tube may have for its ſtock a hollow mandril, open, as well as the tube, at the hinder end, and of a bore ever ſo little larger than that of the tube: the re-action of a ſucceeding nucleus, as it forms, will then puſh on the preceding one; in which caſe, let the borer with its mandril contain ever ſo many of theſe nuclei, it will diſcharge itſelf as faſt as it fills. For effecting the diſcharge at the anterior end of the boring tube, you may make it cloſed at the hinder end with a ſpring; by the re-action of which, the nucleus ſhall be diſcharged, as ſoon as the preſſure produced by the advancement of the borer is removed. To effect the diſcharge by the drawing back of the borer, you may make, in the breach of the tube, a ſmall hole, in which you may fix one end of a rod, which goes through the mandril, and by its other end is faſtened to the bench; this rod, remaining motionleſs, while the borer is drawn back, will prevent the nucleus from being drawn back with it, and ſo cauſe it to drop out. To give a circular configuration to the outſide of a piece, without giving a circular motion to the piece itſelf, the ſame apparatus may

be

be employed as for boring. For this purpoſe, fix the piece on the ſliding-bed, in the direction required, and, inſtead of a borer, fix on the mandril a concave tool, adapted to the external figure required to be given to the piece; ſo that, when the mandril is ſet in motion, the tool ſhall act on the outſide of the piece, as the piece advances. In this manner, round tenons, for example, may be formed at the end of ſpokes of wheels, the ſpoke being placed on the bed, according to the angle of the diſhing.

For pervious boring, eſpecially where the depth is conſiderable, I prefer boring from the two ends, or oppoſite points, at once. The difficulty, which increaſes greatly with the depth, is thus proportionably reduced: where there is force enough at command, the buſineſs is done in half the time, and both orifices are left ſmooth; whereas, in fibrous ſubſtances, moſt ſorts of wood eſpecially, without a ſtrong inciſion previouſly made at the end at which the borer is to come out, it is ſcarcely poſſible to get it through, without breaking out the ſtuff. Theſe two oppoſite borers may each be mounted on a mandril, and muſt, it is evident, be ſo adjuſted as that their axes ſhall lie exactly in the ſame right line. To perform the operation, the piece being placed on the bench, and ſupported at the proper height between the borers, the advancement of the mandrils

drils may be either ſimultaneous or alternate, continuing till each borer has reached the middle: where ſimultaneous, care muſt be taken to apply to each the proper ſtops neceſſary to prevent colliſion; if alternate, to enſure the completeneſs of the perforation, one or both may be allowed to advance a little beyond the middle point. As good a way as any againſt ſuch colliſion is, to make the ſtoppage take place between borer and borer, (for inſtance, by means of a ſtopping-bar added to the ſtock of each,) inſtead of making it take place between the borer and the bench; by this means, there need be no difficulty about making either of them advance beyond the middle line, ſince, in ſo doing, one will repel the other, before the points have come into contact.

II. *Mortiſing or mortiſe-making.* An ordinary mortiſe is only a ſquare or oblong hole, pervious in ſome caſes, impervious in others. For mortiſing, I employ boring, as far as it will go; there remains the ſquaring of the hole, of which preſently. The boring bit I uſually make uſe of, for mortiſing, is either a ſimple tool, like a chiſel, of a breadth equal to the diameter to be given to the bore, or a tool compoſed at its cutting end of two ſuch chiſels, the edges exhibiting the form of a croſs. For a ſquare mortiſe, there needs no more than to make the bore of a diameter equal, mathematically ſpeaking, to that of the circle inſcribed

ſcribed in the ſquare. For an oblong mortiſe, I make a bore the diameter of which is equal to the breadth of the intended mortiſe; and, in the operation of boring, I make the bore traverſe from end to end. The boring tool is accordingly ſharpened at the edges of its leaves, as well as at the ſides; the rectilineal motion, for this purpoſe, might be given to the borer, but I find it moſt convenient to give it to the piece. The boring might be performed by compleating the depth, before you begin to traverſe, or advancing the borer by ſhort ſteps, after each traverſe. For ſtrength, or expedition, you may multiply the leaves of the borer, ſo as to give it the form of the cutting-mandril above ſpoken of, except that the mandril does not (like the borer) cut at its end; but, the more theſe leaves are multiplied, the more they will be apt to clog. The extruſion of the abraded matter may be a little facilitated, by giving to the ſtems of the leaves a kind of ſpiral twiſt. The borer, inſtead of being large enough to cover the whole ſurface, and conſume the whole ſubſtance of the bore, may be as ſmall as it can without prejudice to ſtrength, and thus, by ſkirting the boundaries of the intended bore, cut out, in what I call the circumambient method, a core in the middle. This ſaving of ſubſtance may be extended in ſome degree to impervious borers, by employing a root-cutting tool, upon

upon the principle above explained. Having made the circumambient channel, and, at one end of the oblong, compleated the bore to its depth, by an ordinary borer, and that of the full ſize, now, in the room of the borer, introduce a thin circular cutter or ſaw, of the ſame diameter, which of courſe muſt be fixed to a cutting mandril, unleſs the way has been already cleared for it by a preparatory groove. (See article *Working by a rotative motion of the tool.*) Two pieces may in this way be extracted entire, one on each ſide of the cutting ſpindle. It would be endleſs to enumerate the purpoſes for which theſe various methods of boring may be employed, with more or leſs advantage, according to the difficulty of the work, the hardneſs of the ſtuff, or the value of the material. Shallow beds may thus be made with the utmoſt nicety, for the purpoſes of inlaying boxes, in ivory, for inſtance, or any of the very valuable woods, by excavation, inſtead of compaction: boxes, troughs, or other excavations in any kind of ſtone; as alſo in metals, where caſting or ſtamping would either be impracticable or leſs adapted to the purpoſe. When the bottom of the excavation is to be curve-ſhaped, as in fluted work, the end of the borer muſt of courſe be adapted to the curve. In mortiſing wood, or any other materials, it is common enough to employ boring, for getting out part of

the ſtuff; but then it is performed by hand, and at random, and without the benefit of ſtops or guides, much leſs of the traverſing, the circumambient, or the root-cutting method above deſcribed. The mortiſe or excavation being as yet left rounding at the corners, there remains the ſquaring of it. In the caſe of pervious mortiſes, one ſort of tool for this purpoſe is a raſp or file, with a ſmooth ſtripe on the cutting ſurface, occupying the middle part of its breadth, and running the whole length: on each of its ſides it is uniformly ſmooth; and the breadth from ſide to ſide is ſuch as exactly to fill up the mortiſe. The ſtuff of the rounded corner on each ſide being conſumed by the two rough ſtripes, one on each ſide, the further progreſs of the abraſion will be ſtopped by the ſmooth ſtripe that lies between them, whereby the tool will be prevented, as it is intended to be, from advancing beyond the tangent to the circle: the tool may have its oppoſite ſides ſimilar, ſo that, when one end of the mortiſe has been ſquared, the other end may alſo be ſquared, without taking out the tool. This mortiſe-ſquaring file may be worked either by hand or with the aid of mechaniſm. In the latter caſe, it may move to-and-fro, in a fixed channel, in the manner of the reciprocating ſaw; one end being capable of being diſconnected from its ſteadiments, for the purpoſe of being let into the mortiſe;

mortiſe; or the ſteadiment may be made ſtrong enough at one end, to ſuperſede the neceſſity of adding the ſteadiment at the other: advance now the piece againſt the tool, firſt on one ſide, till the ſquaring is compleat, then on the other, and the buſineſs will be done. Another ſort of tool, for ſquaring a round-ended mortiſe, is a ſtamping chiſel. Of this ſquaring ſtamp, the ſtock muſt, as in other ſtamps, be confined to its courſe, whatever it be, vertical or in any other direction, by fixed channels. To be co-extenſive with the curvature to be ſquared, the chiſel ſhould be hollow, in the form of the half of a hollow ſquare. A pair of ſuch chiſels, for each end of the mortiſe, may be made to fit into the ſame ſtock, ſo as to act at once, by inſerting between them middle pieces of different breadths, according to the length of the intended mortiſe. A ſtamping apparatus, in other reſpects the ſame, may be made to ſerve for mortiſes of different lengths. For the ſame reaſon that the boring ſhould be performed from both ends or ſides, ſo ſhould the ſquaring be. It may be performed either by a ſingle ſtamp, the piece being turned upſide down for the purpoſe, or by a pair of ſtamps, made to work in concert, in oppoſite directions, either ſimultaneouſly or alternately. A third ſort of tool, that may be employed for this purpoſe, is what I call a *raſping punch*; this is a ſtrong thick tool, of which the lower end (*viz.* that end which is to be the

the firſt to enter the mortiſe) is of the ſame ſhape and ſize as the mortiſe is of before it is ſquared; and the other, of the ſame ſhape and ſize as the mortiſe is to be of when ſquared. This configuration changes gradually, from the one ſhape to the other, from end to end. The tool, to enable it to make its way, is cut its whole length into teeth, in the manner of a raſp, file, or ſaw. The length of the tool, that is the ſlowneſs of the change, ſhould depend in ſome meaſure upon the hardneſs of the ſtuff which it is to abrade. A raſping punch of this kind may be made either in one piece, and that of the ſize of the intended mortiſe, with a cutting part for each end of the mortiſe, that is, on each of two of the four ſides of the tool; or in two pieces, for the purpoſe of adapting it, as in the caſe of the chiſel, to mortiſes of different lengths, by the inſertion of a middle piece. For impervious mortiſes, the ſquaring, it is evident, cannot be performed by the file. For the vertical cut, the ſquaring chiſel will ſerve in this ſort of mortiſe, as well as in the other; but there remains the horizontal cuts, neceſſary to meet the vertical ones, and compleat the extirpation. Theſe horizontal cuts may be performed by two equal and ſimilar chiſels, which I call *root-ſquaring chiſels.* Each chiſel conſiſts of a horizontal, and an almoſt upright bar, joined to the horizontal one, at an angle a little leſs than a right angle: the breadth of the

the horizontal bar is exactly equal to that of the mortiſe, at leaſt at the cutting edge. To perform the operation, theſe chiſels are placed in the mortiſe back to back, exactly at the middle line of the length of the mortiſe; a narrow wedge-ſhaped ſpace will then be left between them. A wedge now, of the proper thickneſs, adapted to the length which they are to cut, being introduced, and forced in between them, the operation will be performed. In ſoft ſubſtances, ſuch as wood, for example, the vertical cut will have been ſufficient, and the operation of ſquaring may accordingly be compleated at a ſingle ſtroke. In harder ſubſtances, ſuch as metal, for example, or even ivory, &c. repeated ſtrokes may be neceſſary; though ſtill the horizontal cut may be diſpenſed with. For this purpoſe, a chiſel, cutting one end of a mortiſe at a time, may be worked by a reciprocating apparatus; the piece being advanced againſt the chiſel, in ſuch a manner that but a ſmall part ſhall be cut off at a time. Where the mortiſe is to enter the piece obliquely, it is evident that either the piece or the tool muſt have a tilt, according to the angle. A ſquaring chiſel, mounted as above, may be employed, inſtead of the boring apparatus, for lengthening the mortiſe; but, as the boring apparatus muſt be employed in the firſt inſtance, there ſeem few caſes, if any, in which ſuch ſubſtitution would be attended with any advantage. Some few inſtances,

ſtances, however, there may be, in which the excavation may be performed by the ſtamping chiſel alone, without any boring; one is, that of mitring a ſaſh-bar. This operation may be conſidered as divided into two, conſiſting of a perpendicular inciſion, to the depth of the m[illegible]e on each ſide the bar; and an inciſion on each ſide, in a tranſverſe direction to the former, compleating the excavation. For the firſt operation, I employ a ſtamping tool, compoſed as it were of two chiſels, croſſing each other at right angles, which I call the *ſcoring croſs*: for the other, a pair of chiſels ſeparate from each other, but which I call the *root-cutting chiſels* or *root-cutters*. The marking croſs would reſemble, in its form, one of the borers I uſe for mortiſing, were it not that the arms of the croſs, inſtead of being in the ſame plane with the centre or point of interſection, muſt of courſe extend below it, according to the ſlope of the ſides of the bar which they are to ſtamp. To theſe root-cutters, as well as to the ſcoring croſs, I give channels, to determine the direction of their motion, and ſtops to limit the extent of it.

We meant to have concluded this ſpecification in the preſent number; but, finding it take up more ſpace than was expected, we thought it would be better to defer the reſt of it till our next.

XLIV.

XLIV. *Specification of the Patent granted to Mr.* WILLIAM WOODS, *late of Walberswick, in the County of Suffolk, Master Mariner, but now of Greenwich, in the County of Kent, Engineer; for an improved Hand-Pump, for raising Water out of Ships, and other Places, by which a greater Quantity of Water can be raised in less Time than by any other Pump now in use.*

WITH A PLATE.

Dated March 17, 1796.

TO all to whom these presents shall come, &c. NOW KNOW YE, that I the said William Woods do hereby describe my said invention, and declare that the same is of the description, and to be performed, as appears by, and according to, the perspective views, geometrical plans, and elevations, of the several parts thereof hereunto annexed, and hereinafter particularly mentioned, in manner following; that is to say: Fig. 1, (Plate XVII.) represents a perspective, and in part transparent, view of the pump, and the whole of the apparatus. A *a*, the chamber, in which the

the upper box D works, and which is two feet long; the water being difcharged over the flanch thereof. B *b*, the fuction-pipe, which is alfo proportionably long, according to the depth required; the upper part being fcrewed to the lower part of the chamber A *a*, by means of the flanches O, *o*. C *c*, the lower valve to the fuction-pipe B *b*; being two pieces of circular or fquare plates of brafs, with a piece of leather thereunder, to which the fame is fcrewed, fufficient to cover the whole of the top of the fuction-pipe B *b*; it receives every thing the pipe will admit to pafs without any obftruction, opening entirely clear thereof; the part *c* being fcrewed to the flanch *o*, and thereby operating as a hinge to the valve C. D, the upper box; *d*, the clapper thereto, which will be down when the lower valve C is up; and will be up when the lower valve C is down. E *e*, the fpear to the ftaple of the upper box D, which prevents friction, it paffing up and down through the ftay H *b*, at H, without a poffibility of the box D being thrown out of its perpendicular direction. F *f*, the ftaple of the box D. G *g g*, the pump rod or tongs; the lower part thereof working upon the bolt V, which paffes through the tongs and fpear E *e*, aided by the ftay H *b*, through the eye of which the fpear paffes, and keeps the box D in a perpendicular direction, and thereby prevents friction

tion on the ſides, at the working barrel or chamber; the upper part thereof being bolted through the hole in the break N N *n n*, which bolt being removed, will occaſion a greater or leſs dip in the barrel, and therefore diſcharges more or leſs water, according to the force applied. H *b*, the ſtay to the ſpear of the pump-box D, through which the ſpear E *e* paſſes, during the working thereof, and unſhips out of the ſocket at I. Y, the pin and chain, to faſten the ſtay H in the ſocket I. I, the ſocket, to receive the ſtay H, which is affixed to, and part of, the ſtauncheon L. K *k*, the ſtep, to receive the ſtauncheon L, which may, if neceſſary, be placed level with the floor or deck. L, the ſtauncheon, ſhipped into the ſtep K *k*, affixed to the deck, or elſewhere. M *m*, the nails or ſcrews, to faſten the ſtep K, and alſo the flanch of the chamber A *a*, to the floor or deck. N N *n n*, the pump break, ſhewing the bow, for the convenience of the men working thereat. O, *o*, the flanches to the lower part of the chamber A *a* and the ſuction-pipe B *b*. P, the pin or pivot affixed to, and part of, the pump break, which ſhips into the ſtauncheon L. Q *q*, the bolt which paſſes through the head of the tongs G *g g*, and faſtens the ſame in the break. R, (Fig. 14.) is a perſpective view of a ciſtern head, which may occaſionally be ſcrewed on the head of the pump, that the water may be led by

 a hoſe,

a hofe, or fhoot over the fhip's fide, or for furnifhing water to wafh the decks, or for any other purpofe where it is neceffary to fave water. S, the flanch thereof.

REFERENCES to the different PARTS, fhewn feparately in Plate XVII.

Fig. 2. Chamber and fuction-pipe.

Fig. 3. Elevation of the fpear, ftaple, and box.

Fig. 4. Side elevation of ditto, fhewing the clapper open.

Fig. 5. Plan of the underfide of the box.

Fig. 6. Plan of the top of the box, fhewing the form of the clapper.

Fig. 7. Elevation of the tongs.

Fig. 8. Plan of the pump break.

Fig. 9. Elevation of the ftauncheon.

Fig. 10. Elevation of the ftay.

Fig. 11. Elevation of the ftep, the dotted lines fhewing the dimenfions of the focket to receive the ftauncheon L.

Fig. 12. Plan of ditto, fhewing the focket to receive the ftauncheon L.

Fig. 13. The pin and forelock, which confines the fpear and ftaple to the tongs, below, and the tongs and break together, above.

The

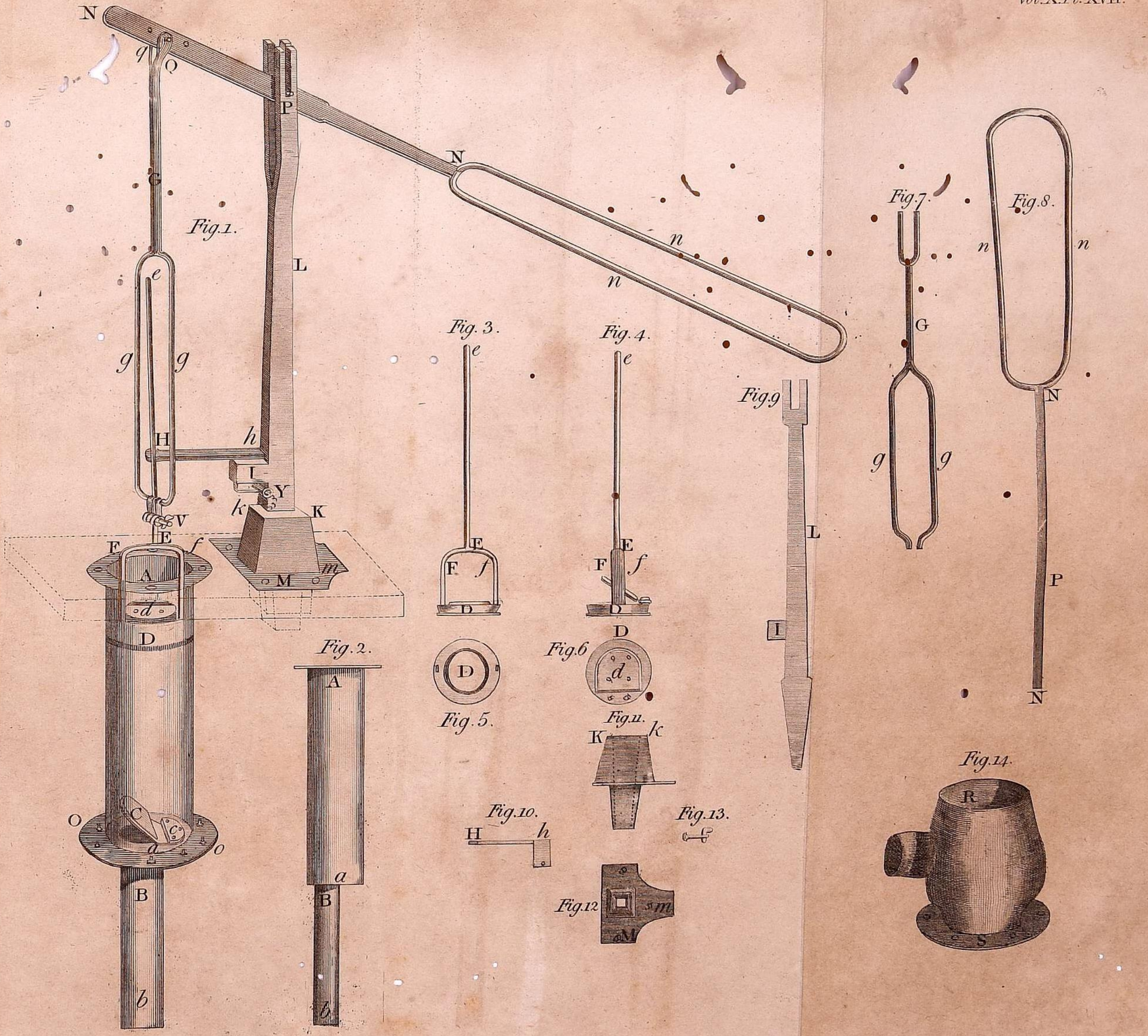


Fig. 1.
Fig. 2.
Fig. 3.
Fig. 4.
Fig. 5.
Fig. 6
Fig. 7.
Fig. 8.
Fig. 9
Fig. 10.
Fig. 11.
Fig. 12
Fig. 13.
Fig. 14.

The whole of the pump and apparatus, above ſpecified and deſcribed, (excepting the leather upon the flanches,) may be made of any metal, and, for ſome purpoſes, of wood, chambered or unchambered; but, for moſt purpoſes, copper, braſs, or iron, is preferable. Its ſimple conſtruction is ſuch, that the whole of the apparatus thereof may be ſhipped and unſhipped, by one perſon, in the ſpace of one minute; it may be removed from one place to another, by two men, in the ſpace of ten minutes, in caſe of the limbers being choaked, or otherwiſe, though it is not liable to be choaked at all; and, in ſhips of war, privateers, or others, clearing for or in action with an enemy, very little time is required to remove the whole away; and the chamber thereof, being level with the deck, will not be ſo liable to be ſhot away as thoſe now in uſe. But, laſtly, and principally, it raiſes a greater quantity of water out of ſhips, and other places, in leſs time than any other pump now in uſe. In witneſs whereof, &c.

XLV. *Specification of the Patent granted to Mr.* JOHN RICHTER; *for his Invention of an Art or Method of inlaying Scagliola or Plaster, in and upon Marble and Metals, to imitate Flowers, Trees, Fruit, Birds, Beasts, Landscapes, and all Sorts of Ornaments.*

Dated Dec 28, 1770.—Term expired.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said John Richter do hereby declare, that my said invention of an art or method of inlaying scagliola or plaster, in and upon marble and metals, to imitate flowers, trees, fruits, birds, beasts, landscapes, and all sorts of ornaments, is described in the manner following; that is to say: First, procure statuary marble, or metal, which must be finely polished. Secondly, take size-water, and mix the same with common whiting; brush the same all over the polished marble, or metal. When the same is dry, draw the design thereon, and cause that part within

within which is meant to be inlaid, to be cut out a quarter of an inch deep. Thirdly, take the ſcagliola or plaſter, which muſt be finely ſifted, and have all the neceſſary colours finely ground, which muſt be ſuch as are uſed in oil by the painters. Mix the ſcagliola or plaſter into a paſte, with ſize-water: add to the ſame ſuch colours as the deſign requires; then, with a ſmall trowel, lay the ſame into the cavities that are intended to be filled up, and let the ſame remain until it becomes dry and hard; after which, level the ſame, to the face of the marble, or metal, with a ſmall plane or knife, which muſt be very ſharp. Care muſt be taken that the corners of the plane or knife do not take off the poliſh of the marble, or metal. Then take cuttle-bone and water, and grind the ſame more level than the plane or knife may have left it. After waſhing the ſame well, take ſcagliola or plaſter, mixed with the ſame ſize-water and colours, but more liquid. Then lay the ſame over the waſhed parts, with a trowel, ſo as to ſtop thoſe pores which may be perceived. Let this remain until the ſame comes to be dry and hard: and then again, with cuttle-bone and water, grind that, ſtopping off ſo that none remains but in the pores. Fourthly, let the work dry for ſix days, then paint the ſame over with olive oil; but great care muſt be taken

not

not to oil the marble, or metal. When the ſame is dry, take tripoli, ground into a fine powder, and, with a piece of ſoft leather, rub over the work until the ſame has obtained a fine poliſh. Fifthly, the ground of the marble, or metal, muſt be made rough, for the ſcagliola or plaſter to ſtick the better upon it. Laſtly, in order to lay ſcagliola on metal, without the metal appearing on the ſurface, the ſcagliola muſt be laid on mixed with ſuch colours as are intended to be the ground, the ſame to be levelled as above; then ſtop the ground, and draw the deſign upon it. The reſt of the proceeding as above deſcribed. In witneſs whereof, &c.

XLVI. *Description of an Instrument called a Sward-Cutter*; also of two Harrows. By the Honourable* ROBERT SANDILANDS.

WITH A PLATE.

From the Letters and Papers of the Bath and West-of-England Society for the Encouragement of Agriculture, &c.

FIG. 1, No. 1, (Plate XVIII.) A A, &c. a ſquare frame, three feet four inches from the fore to the hind part, by four feet three inches, the breadth of the machine within ſide; the timber (when of fir) four inches ſquare, placed on two wheels B, B, three feet diameter, a little more or leſs, (the old fore wheels of a chaiſe may anſwer the purpoſe,) to ſupport the hind part of the machine.

* This inſtrument, which was invented by Mr. Sandilands ſome time ago, is now much improved, particularly with regard to the expence, being reduced from 15l. or 16l. to 5l. or 6l.

C, C, &c. six strong pieces of wood, called *bulls*, three feet long, five inches and a half broad, the thickness six inches at E, No. 2, and tapering to three inches at F. Into these bulls are fixed the cutting wheels, which are of iron, thirteen inches diameter, three quarters of an inch thick at the centre, (about an inch diameter,) for piercing holes to fix the iron axles in; from that they are to be of such thickness as to allow the edges to be well steeled. These wheels are fixed by two bolts going through the bulls, with eyes on one end, for the axles of the wheels to run in, and nuts and screws on the other, to make them very firm by, and sunk in the bulls, to prevent their interfering with the weights L, L, &c. resting on them.

G, G, &c. No. 1, are hollow pieces of wood, called *thorles*, each three inches and a half long, which inclose the bolt M M, and keep the bulls C, C, &c. at their proper distances, but may be made longer or shorter at pleasure, as the sward requires to be cut in larger or smaller pieces. They are in two pieces, bound together, and jointed by a strap of leather, or cord, which allows them to be readily changed, when the cutting wheels require to be kept at more or less distance.

The iron bolt M M, No. 1, goes through two pieces of wood, or iron, seven inches long, clear of the wood, supported by iron stays, fixed to the

the frame, and through all the bulls, as at T, No. 3; it requires to be ſtrong, as the draught of the horſes terminates there.

H H, Nos. 2 and 3, a cylinder, or ſegment, of wood, ſeven inches diameter, called a *rocking-tree*, which goes acroſs the frame, and moves on the pivots fixed into it, one at each end. It is ſupported by an iron bolt, or piece of wood mortiſed into the frame, eight inches high, (as appears in the figures,) to which ſix chains or ropes are fixed by hooks, at different diſtances, as you want your cuts, *viz.* nine, eight, ſeven, or ſix inches from one another, and are joined to the end of each bull, in which the cutting wheels run; ſo that, when the rocking-tree is turned about by the lever I, fixed in the middle of it, all the bulls, with their cutting wheels, are raiſed out of the ground at once, as in No. 3; by which means, the machine may be turned, or moved from place to place, with great eaſe, without any danger of ſtraining the wheels.

N. B. The rocking-tree is not delineated in No. 1, in order that the plan of the frame may be more eaſily underſtood.

L, L, &c. Nos. 1, 2, 3, are weights of free-ſtone, twenty-ſix inches long, and ſix inches broad: the under one four inches thick; the upper one of the above dimenſions, and three inches thick. They

will weigh (according to the gravity of the stone) about four stone the under, and three the upper; all of them having two holes in them, through which iron spikes, firmly fixed in the bulls, pass, in order to keep them steady.

When the ground is easily cut, the under stone, of four stone weight, may answer; when more difficult, the other stone, of three stone weight, may be added, so that every wheel may have seven stone weight upon it, which has been found sufficient for the stiffest land and toughest sward the machine has ever been tried on. Cast-iron weights would answer still better, but are more expensive, which the inventor wishes by all means to avoid.

The lever I, (Nos. 2 and 3,) which ought to be five feet long, must have a sliding-rope on it, fixed to the back part of the frame; so that, when the cutting wheels are all taken out of the ground three or four inches, by the rocking-tree's being turned partly round by the lever, the rope is fixed to it, by putting a loop at the end of the rope over the pin R, No. 3, (it ought to be placed three feet four inches from the extremity of the lever I,) which keeps all the cutting wheels out of the ground till the machine is turned, and then, by moving the loop off the pin, it slips back towards the frame, and the lever is gently let back to its place, as in No. 2, by which

which the cutting wheels are put into their former poſture, by the weights fixed on the bulls in which they run. The levers may be made of good tough aſh.

P, No. 1, is a ſmall bolt of iron, with a hook on one end of it, (one is ſufficient,) to ſtrengthen the bolt M M, to be hooked on the centre of it, and joined to the frame by a nut and ſcrew.

The grooves in which the cutting wheels run, may be covered below, at the hinder part, with a plate of thin black iron, ſix inches long, three inches broad, having a ſlit in it where the wheels run, to prevent (if found neceſſary) any graſs, weeds, or ſmall ſtones, from filling the grooves, and clogging the wheels; the form of it is ſeen at the letter *i*.

To the frame, as ſeen at No. 1, are fixed (for a double-horſe ſward-cutter) three ſhafts, as in a waggon, of ſuch length, ſtrength, and diſtance from one another, as the workman may think proper.

For a ſingle-horſe ſward-cutter, (which has only four cutting wheels,) a pair of ſhafts are uſed, and may make the two ſides of the frame, without any joinings. The width of the frame, in proportion to the double-horſe ſward-cutter, is as four to ſix.

It is recommended, for a double-horſe ſward-cutter, to have eight bulls and wheels, that when it

it is used to reduce hard cloddy summer fallow, or land for barley, before the last furrow, or even after it, the whole weight, forty-two stone, employed in sward-cutting the stiffest land and toughest sward, may be applied to the eight bulls, then at six inches from one another: the four-stone weights to be applied to six of the bulls, and two of the three-stone weights to each of the additional bulls; which it is thought will prove a sufficient weight for the purpose, and will effectually prevent a clod, of more than six inches broad, from escaping being broke to pieces.

In the same manner, a single-horse sward-cutter may have six bulls for the above-mentioned purpose: the twenty-eight stone belonging to it, divided thus; the four-stone weights to four of the bulls, and two of the three-stone weights to each of the additional bulls. It was thought better to be rather minute here, than to trouble the person employed in using the sward-cutter with any calculations.

That the instrument may come as cheap as possible to the public, the inventor is of opinion, that the expence of the two wheels, and the iron axle, (which is considerable,) may be saved, by joining strongly to the frame, at S, No. 3, a piece of wood with a little curve at the extremity of it, resembling the foot of a sledge, formerly much used in Scotland, to carry in the

corn

corn from the field; the part of it resting on the ground being kept eighteen inches (the half diameter of the wheels) from the frame, by a strong support of wood.

As the two outer bulls, next the frame, are apt to get under it, so as to prevent the cutting wheels from being taken out of the ground, a thin slip of iron, fixed to the inside of the frame, nearly opposite to the back end of the bulls, of convenient length, will be found necessary.

Manner of using the Machine herein described, and Advantages attending it.

The original intention of this machine was to prepare old grass land for the plough, by cutting it across the ridges, in the beginning of or during winter, when the ground is soft, in order to answer all the purposes that Mr. Tull proposed by his four-coulter plough, so strongly recommended by him for bringing grass ground, that has been long rested, into tilth. This the sward-cutter has been found to do much more effectually and expeditiously; as Mr. Tull's plough, with four coulters, cut the sward in the same direction with the plough, and is liable, from every stone, or other obstruction any of the coulters meet with, to be thrown out of its work altogether, or the instrument broke; to which

 accident

accident the ſward-cutter, conſiſting of four, ſix, or more cutting wheels, is never liable, from their being entirely independent of one another, cutting the ground acroſs the ridges before ploughing, and rendering that operation eaſier to two horſes than it would be to three without its being cut. The furrow being cut acroſs, falls finely from the plough; in ſquares of any ſize required, not under ſix inches, in place of long ſlips of tough ſward, ſeldom broke, or imperfectly, by the four-coultered plough.

Any perſon who reads Mr. Tull's deſcription of his four-coultered plough, and what he propoſed by it, will ſoon ſee what great advantage the ſward-cutter has over it, in producing the deſired effect of bringing old reſted graſs ground into tilth; an object univerſally allowed to be of no ſmall importance to agriculture.

This inſtrument is very fit for preparing ground for burn-bating, as it will ſave much hand-labour.

It may be properly uſed for croſs-cutting clover of one or two years ſtanding, to prepare the ground for wheat, if the land be ſtiff and moiſt enough.

It may be applied to cutting and croſs-cutting paſture-ground, intended to have manure of any kind put upon it to meliorate the graſs. In this it will far exceed the ſacrificator, mentioned in one

one of Mr. Young's tours; as that inftrument is liable, as well as the four-coultered plough, to be thrown out of its work, when meeting with a ftone, or other interruption. This the fward-cutter is proof againft, which is looked on as its greateft excellence.

In preparing for barley; the fward-cutter excels a roller of any kind, in reducing the large hard clods in clay land, occafioned by a fudden drought, after its being ploughed too wet; and it is likewife very proper for reducing fuch clay land, when under a fummer fallow. In this operation, the fward-cutter is greatly to be preferred to the cutting roller, (likewife mentioned by Mr. Young in one of his tours,) the wheels of which are all dependent one on another, fo that, when one is thrown out by a ftone, three or four fhare the fame fate; befides, the cutting roller has but feven wheels in fix feet, and the fward-cutter has fix in four feet three inches, nine inches diftant; and, if neceffary, may have them fo near as fix inches.

After old grafs ground is cut acrofs with the fward-cutter, and ploughed, it has a very uncommon and worklike appearance; from each fquare, turned over by the plough, being raifed up an inch or two at the fide laft moved by the earth-board; fo that the field, when finifhed, is all prettily waved, and refembles a piece of water when blown on by a gentle breeze. By this means, a great

a great deal of the land's surface is exposed to the frost, and other influences of the air, which cannot fail to have a good effect on it.

Two horses are sufficient for the draught of a double-horse sward-cutter; and one horse for a single-horse one: one man manages the machine, and drives the horses. He begins his operation by first measuring off twenty or thirty paces from the machine, less or more, as he inclines, and there fixes a pole: he then cuts the field across, as near at right angles with the ridges as he can. When the cutting wheels are past the last furrow about a yard or so, and the machine is upon the outermost ridge of the field on which it is to turn, he must stop the horses, then take hold of the lever I, No. 2, and, by pulling it to him, he raises the cutting wheels out of the ground, which are kept so, by the loop of the rope being put over the pin R, in the lever I, as in No. 3, till the machine is turned and brought to its proper place; which is done by measuring off the same distance formerly done, on the opposite side of the field. When the cutting wheels are exactly over the outermost furrow, then, on the horses being stopped, the loop is slipt off the pin R, and the lever returned to its former place, as represented in No. 2, which allows the weights L, L, &c. to force the cutting wheels into the ground again. The man then goes on, till the interval betwixt the first and second stroke of the machine

is

is all cut. In this manner the field is to be finished, after which, you may begin to plough when you pleafe.

N. B. There muft be a pole at each fide of the field.

It is of no confequence whether the land to be fward-cut is in crooked ridges or ftraight, in flat ridges or in very high-raifed ridges, fuch as are frequently met with in Scotland. Be the furface ever fo uneven, it does not fignify, as the cutting wheels being all independent of one another, are forced by their weights into every furrow or hollow.

One fward-cutter will cut as much in one day as fix ploughs will plough.

Any common wright and fmith may make the inftrument. It is very ftrong, very fimple, eafily managed and moved from place to place; and, if put under cover, will laft many years.

The land may lie feveral months in winter, after being fward-cut, when there is no vegetation to make the cuts grow together again, before it is ploughed; but the fooner it is ploughed after cutting the better, that it may have the benefit of all the winter's froft, which makes it harrow better and eafier at feed-time.

When the ground is harrowed, the harrows ought to go with the waves that appear after ploughing, not againft them, as by that means they are lefs apt to tear up the furrows all cut

into fquares. This need only be attended to refpecting the firft two *tines*, as they are called, of the harrowing.

Fig. 2. is the plan of a harrow invented by Mr. Sandilands, which he recommends in a particular manner, and to which he has given the name of the *Chain and fcrew harrow.* Its properties are, that if your ridges are high, and you wifh to harrow them from one end to the other, by lengthening the chain, (which the fcrew commands,) the harrow, when drawn along, forms an angle downwards, and miffes none of the curve of the ridge, fo far as it extends, which may be nine feet, the diftance from A to B. The diftance from C to D is five feet fix inches. When the crowns of the ridges have got what is thought fufficient harrowing lengthwife, you fhorten the chain, by the fcrew, which forms an angle upwards: the harrow is then drawn by the horfes, one on each fide of the furrow, which completely harrows it, and the fides of the ridge, if eighteen feet broad.

When you want to harrow even ground or high ridges acrofs, by the fcrew you can bring the harrow to be horizontal, fo as to work as a folid harrow without a joint.

The teeth are formed and fixed in the common manner, fquare, not in the fafhion of coulters, and are nine or ten inches below the wood, and of fuch ftrength as it is thought the land requires. The teeth cut or rather tear the ground

at

at every four inches, without variation, though ſeemingly placed irregularly, without any riſk of choaking, except ſometimes at the extreme angles, where the teeth are neceſſarily near each other; they may be cleaned with the greateſt eaſe, by raiſing them a little from the ground. The figures 1, 2, &c. point out where the twelve teeth on each ſide the harrow are placed.

Where a ſtrong brake-harrow is not neceſſary, by making the teeth ſhorter or lighter, you may have forty-eight teeth, which will tear the ground at every two inches, or near it, cover the ſeed well, and make a fine mould.

It is recommended that harrows, for every purpoſe, and of any ſize, be made on the above principle, by which, no tooth can ever follow the track of another, and all are kept conſtantly acting.

Figs. 3 and 4 are the plan and profile of a harrow, likewiſe invented by Mr. Sandilands, called a *Wrack-harrow*, from its very expeditious manner of bringing the wrack or roots of couch-graſs and other weeds together. It conſiſts of a plank of timber, ſix feet long, nine inches broad, and two inches thick, in which there are two rows of teeth fixed, twelve in front, and thirteen in rear; about four inches row from row, and about five inches from each other, which, in effect, brings the teeth to operate at two inches and a half one

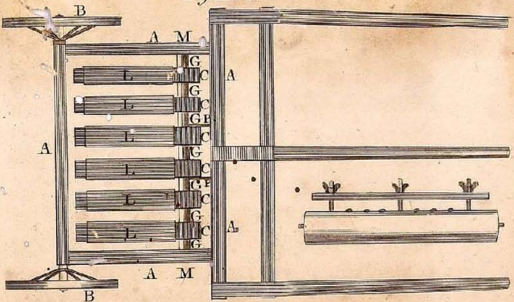
from

from another. They are in length about seven inches below the wood, three quarters of an inch square, not sharp, but pointed diamond-ways, so as not to penetrate the soil, but only to catch what, by thorough harrowing before, is brought above ground. To the plank is joined shafts for a horse, and handles for a man, of such length and strength as any workman may think necessary.

The manner of using the harrow is as follows: when the land is so well harrowed as that all the roots of the couch-grass, &c. are brought to the surface, the harrow is drawn across the field; the holder pressing a little, not much, on the handles, till the plank is immediately over the first furrow; on which, without stopping the horse, he suddenly lifts the harrow, which the shafts support before; by this means, all the stuff gathered by the harrow drops in the furrow. Thus he must proceed; and, when he has crossed the field, he turns to the right or left, and crosses the ridges again, as before mentioned, observing not to miss any of the land, and keeping close by the last track. From this operation, the whole wrack, &c. is left in the furrows, ready to be carted off the field, or burnt, as the farmer chooses. If the horse is not steady, a boy must be employed to lead him.

XLVII.

Fig. 1. No. 1.



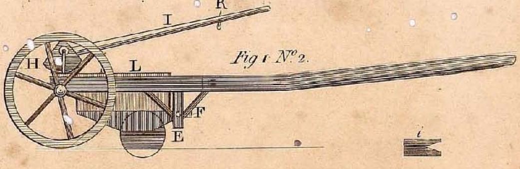


Fig. 1. No. 2.

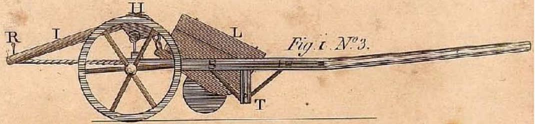


Fig. 1. No. 3.

Fig. 2.

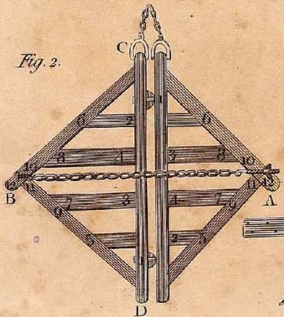


Fig. 3.

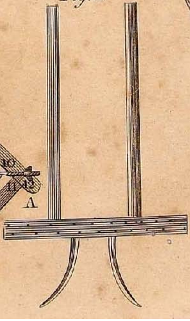
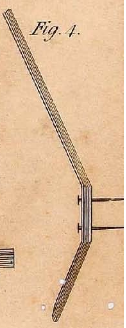


Fig. 4.



XLVII. *On the Rectification of Sulphuric Ether. By M.* Dizé.

FROM THE *JOURNAL DE PHYSIQUE.*

SULPHURIC ether is a very valuable medicine, when uſed in ſufficient doſes. Its agreeable flavour renders it very pleaſant, both to the ſmell and taſte; and thoſe who are in the habit of uſing it, are very particular reſpecting its fragrance.

The etherial odour was known and admired by the antient chemiſts. Vanhelmont relates, that being one day employed in diſtilling a mixture of alcohol and ſulphuric acid, the ſmell this combination ſpread over his laboratory was ſo pleaſant, that it attracted the birds which happened to be near. Admitting this account to be a little exaggerated, it may ſtill ſerve to ſhew, that this chemiſt was very much ſtruck by the peculiarity of the etherial odour.

The odour ariſing from ſulphuric ether is peculiar to it; in which property it is ſimilar to other compoſitions of the ſame kind, every known ſpecies of ether being diſtinguiſhed by its ſmell. Thoſe whoſe buſineſs it is to make theſe preparations,

tions, ſhould conſequently take great care that each ſpecies poſſeſs this diſtinguiſhing character, as a mark whereby its goodneſs and purity may be known.

It is chiefly in the rectification of theſe preparations, that the development of the etherial odour is perceived in its pureſt ſtate. Conſequently, the choice of the re-agents, and the degree of heat employed, cannot be matters of indifference; for, although it may be eaſy for a chemiſt to prepare ſome kinds of ether for the purpoſe of medicine, ſo that they ſhall be always the ſame in ſmell and in ſtrength, that is not the caſe with reſpect to ſulphuric ether, the properties and ſmell of which (owing to variations in the rectification) are very uncertain. The rectification of this preparation is abſolutely neceſſary, if we wiſh to carry it to its higheſt degree of perfection. In order to do ſo, many methods have been propoſed, with a view to prevent the ſulphureous acid gas (which is formed towards the end of the operation) from riſing, and combining with the ether. This gas, which is very volatile and ſuffocating, deprives the ether of its true ſmell, and renders it a very diſagreeable medicine, by the change it produces in its properties. I need not mention all the methods uſed for the above purpoſe; but ſhall deſcribe the method practiſed in moſt ſhops, in order to compare it

with

with that I am going to propoſe, which has always ſucceeded with me, in the large way.

The uſe of potaſh ſeems to be generally preferred; but, as the quality of this alkali varies very much, it cannot be ſuppoſed to produce always the ſame effect, in the hands of the generality of chemiſts. This obliges them, every time they want to uſe it, to try what quantity will be ſufficient for their purpoſe; and, as a laſt reſource, to be guided, in that reſpect, by their ſmell; a criterion by which different perſons will judge very differently.

Beſides, potaſh cannot be very fit for the purpoſe, becauſe, having a great affinity with water, it diſſolves in the phlegm of the rectified ether, and forms a paſty maſs at the bottom of the veſſel; which maſs, when the veſſel is ſhaken, runs into lumps, thereby preventing the particles of the ſalt from coming into contact with the ſulphureous acid gas: theſe circumſtances render the combination of theſe two ſubſtances difficult, tedious, and incomplete, and occaſion other inconveniences, which I ſhall mention hereafter.

Experience having at length ſhewn me the uncertainty, tedioufneſs, and inſufficiency of potaſh; being alſo urged by the neceſſity of making a large quantity of ether at a time, and being anxious to produce a medicine that ſhould be good, and always the ſame, I made the following experiments, the reſult of which was ſatisfactory.

I ſaturated four pints of water with ſulphureous acid gas, and divided it into four equal parts, in bottles with glaſs ſtoppers. Into one of them I put ſome red calx of lead; into the ſecond, yellow calx of iron; into the third, red calx of mercury; and, into the fourth, calx of manganeſe, finely powdered.

The red calx of lead had very little effect on the ſulphureous acid gas; the colour of the calx at the end of ſome days, having loſt very little of its brilliancy.

The oxide of iron was more powerful; after a few minutes, its yellow colour turned to a dark grey. The day after, almoſt the whole of the calx was become black, being changed into martial æthiops: the mixture had entirely loſt the ſmell of ſulphureous acid gas.

The red oxide of mercury inſtantly loſt its colour; turning firſt to a dirty white, then to a grey. The day after, it was yellow, and ſeemed changed into turbith mineral. While the gas acted upon this calx, bubbles of air were ſeen to ariſe, and to mix with the fluid; the ſmell of the gas went off in about an hour.

The calx of manganeſe was the moſt powerful of all. Its colour ſoon changed to a dark grey, and the ſmell of the gas was no longer perceptible.

I repeated theſe experiments, with the ſame metallic calces, uſing, inſtead of water, four different quantities of ſulphuric ether, with which, during

its

its preparation, I had taken care to combine a large portion of ſulphureous acid. The reſult of the experiments was nearly the ſame as before, except that, with ſulphuric ether, the red calx of lead became white; whereas, with water impregnated with the gas, its colour had loſt nothing of its brilliancy, at the end of ſeveral days.

The four quantities of ſulphuric ether were then rectified ſeparately: each of them had a very pleaſant ſmell, particularly that which had been digeſted with red oxide of mercury, and that with manganeſe.

By reflecting on the phænomena which occur in the neutralization of the ſulphureous acid gas by metallic oxides, it is eaſy to conceive the nature of the attraction which takes place, and that this neutralization is owing to the oxygen, which is combined with the metal.

The following is the manner in which it may be explained. Sulphureous acid is nothing more than ſulphur not ſaturated with oxygen; the inſtant it can abſorb as much of that principle as is neceſſary for its ſaturation, it becomes ſulphuric acid, and loſes its former diſtinctive properties, *viz.* its ſuffocating ſmell, its great volatility, &c.

The experiments I have juſt deſcribed ſhew, that thoſe metallic ſubſtances whoſe oxides I made uſe of, have leſs affinity with oxygen than ſulphureous acid has; from which it neceſſarily follows, that the ſulphureous acid takes from them

that portion of oxygen which is neceſſary to ſaturate it, and to convert it into ſulphuric acid. The intenſity of colour alſo which the various metallic oxides acquire, when they are carried to their higheſt degree of oxidation, is diminiſhed, in proportion to the oxygen taken from them by the ſulphureous acid; which loſs of oxygen brings back the metals to a leſs degree of oxidation. A perſon whoſe ſmell is not ſufficiently delicate to diſcover ſmall portions of ſulphuric acid, (the preſence of which would be injurious to the fine ſmell of the ether,) will find, in the oxide of mangaueſe, or that of mercury, or of lead, a criterion by which he may diſcover them; for, he may be certain, that the ſulphureous acid gas is entirely neutralized, when he perceives that the metallic oxide, with which he tries the ether, preſerves its brilliancy of colour.

It muſt be evident, that as ſoon as the ſulphureous acid is changed into ſulphuric acid, it will act upon, and combine with, the metallic ſubſtance which it has deprived of its oxygen; and, even if it did not combine with it, there would be no fear that this acid would riſe with the degree of heat neceſſary to the rectification of ether. This is another advantage in favour of the proceſs here deſcribed, compared with that in which potaſh is made uſe of, and is what I hinted at in a preceding paragraph.

In

In fact, when potaſh is employed to neutralize the ſulphureous acid, this acid combines with the alkali, without undergoing any change; ſo that, when any force capable of decompounding this combination is applied, the ſulphureous acid appears again, with all its uſual properties.

When ether is rectified with potaſh, it generally happens, at the end of the operation, that the degree of heat is ſufficient to decompoſe a part of the ſulphate of potaſh which was formed, and diſſolved in the phlegm of the ether. For that reaſon, we frequently obtain a ſulphureous ether, after having rectified it, and previouſly ſaturated it with potaſh. From the ſame cauſe, alſo, ariſes the difference obſerved in ſulphuric ether; the varieties of which preparation, with reſpect to ſmell, &c. are almoſt as numerous as the ſhops from which it may be procured.

There will be no reaſon to fear this effect of heat, when ether is treated with the oxide of mangane ſe, or of mercury; the reaſon of this is evident from what has already been ſaid.

Relying on the experiments above deſcribed, I ventured to rectify fifty ounces of ether with oxide of manganeſe, finely levigated, that being the cheapeſt of the fore-mentioned oxides. The operation ſucceeded perfectly well; was ſooner finiſhed, and leſs troubleſome, than when potaſh is uſed; and produced an ether of the utmoſt fragrancy.

Ever

Ever ſince I made uſe of this proceſs, my ether has always been excellent in quality, and always equally ſo; it cannot therefore be improper to give a deſcription of the manner in which I perform the operation.

The ſulphuric acid which the ether may happen to contain having been neutralized, by digeſtion with oxide of manganeſe, the ether is poured into a ſmall pewter ſtill, capable of containing fifty ounces. This ſtill is placed in a veſſel three quarters full of water; after which, a head and worm, of a proper ſize, are fitted to it. The worm is fixed in a caldron full of cold water, which is perpetually renewed at the lower part of the veſſel, and runs off by an opening made at the upper part of it; the upper ſurface of the water, (which is the part that firſt acquires heat,) being by this means conſtantly carried off, the worm is always kept at the ſame degree of heat. In the progreſs of the diſtillation, I raiſe the heat to about 113 degrees. The operation is generally finiſhed in the courſe of the day.

I have tried the above proceſs, in the large way, for the ſpace of three years, and I have remarked that it produces one ſixth more in quantity than the uſual methods of rectification, by means of a retort and a receiver.

XLVIII.

XLVIII. *Description of the Manner of polishing and silvering Plates for Looking-Glasses, (cast at St. Gobin,) at the Manufactory in the* Fauxbourg St. Antoine, *at Paris.* By M. SAMUEL BERNARD.

FROM THE *JOURNAL POLYTECHNIQUE.*

THESE plates of glass are cast at St. Gobin, because the materials of which they are composed, and the fuel necessary for melting them, are more conveniently procured there than at Paris. But, as it is necessary that a large quantity of these glasses should be kept at Paris, that being the place where there is the greatest demand, even for those which are intended for exportation into other countries, they are brought there in the rough. In that state, being more thick, they are less subject to be broken; and the inconvenience which would arise from their being scratched, or having the silver rubbed off, is also thereby avoided. If only a few were broken after being finished, (particularly if they were of a large size,) the loss would be more considerable than that occasioned by the breaking of a much

much greater number in their rough ſtate; it being very difficult to finiſh them in a perfect manner, and keep them, at the ſame time, of their full ſize: thoſe which are obtained in that ſtate bear a very high price. Beſides, in the Magazine at Paris, to avoid unneceſſary expence, they poliſh and ſilver only thoſe plates for which orders are given.

For the reaſons above mentioned, the plates are brought, in a rough ſtate, from St. Gobin to Paris, both by land and water; and, to guard against accidents, they are placed on end, in a kind of wooden frame, leaning one againſt the other, and kept in at the bottom by a ridge, which admits within it the thickneſs of the plate. Theſe frames are ſuſpended, by very elaſtic ſprings, on carriages, which are alſo hung upon ſprings. Between the plates are put, at certain diſtances, ſlips of elaſtic cloth, which prevent them from ſtriking againſt each other.

When the glaſſes have been caſt and annealed, (that is, cooled gradually,) they are pretty ſmooth (but by no means ſufficiently ſo) on that ſide which lay againſt the plate of metal on which they were caſt; on the other ſide they are rough and undulated: both ſurfaces are to be ground perfectly even. Before that operation is begun, they are examined, to ſee whether they have not ſome defects, ſuch as deep cavities, or cracks,

cracks, which might hinder their being poliſhed in their original ſize. If any ſuch defects are found, they are cut off, by means of a diamond, in ſuch a manner as to keep the plates as large as poſſible. If the line made by the diamond is near the edge of the plate, the part to be taken off is ſeparated by blows with a hammer: if it is in the middle, the weight of the glaſs, acting as a lever, is ſufficient for the purpoſe. If the glaſs was not what the workmen call well annealed *, it would not bear to be cut; but, when

* As the operation of annealing is very important, and the term itſelf improper, becauſe it leads to falſe ideas of that operation, I ſhall here give ſome account of it. Annealing conſiſts in cooling a body, which is dilated by heat, in a ſlow and progreſſive manner. To anneal plates of glaſs, they are put, immediately after being caſt, and while yet ſoft, (upon the metal plate on which they were caſt,) into a very hot oven, from which all flame and ſmoke are excluded, as they might tend to injure the colour of the glaſs. The fire is ſuffered to burn out gradually, and the plates grow cool, by degrees, as the fire abates. By this means, the contraction of the glaſs takes place very ſlowly, and equally in all directions. The particles of the glaſs approach nearer each other, and adhere together more ſtrongly. If, on the contrary, the glaſs is ſuffered to cool in the open air, the following is the reſult. The glaſs, in melting, had increaſed in bulk; its ſurface, by being the firſt part cooled, and rather ſuddenly, preſerves nearly the ſame dimenſions. The internal particles, as ſoon as the heat which kept them at a diſtance from each other is entirely diſſipated, are incloſed

within

when it is well annealed, it is more flexible, and leſs brittle, than is commonly ſuppoſed. This is proved, not only by the operation juſt ſpoken of, but alſo by the following experiment of M. Buffon. He had a plate of glaſs fixed in a frame; over the middle of the plate was a ſcrew, the end of

within a larger ſpace, and conſequently remain farther aſunder: there is therefore a vacuum between theſe particles, and they tend to approach each other, both by their mutual attraction, and the preſſure of the external air. For which reaſon, if this double effort is very ſtrong, the glaſs ſplits, and breaks of itſelf; or, if the ſurface of the glaſs ſhould be able to reſiſt the effort, a very ſlight blow, or (what is more effectual) a trifling ſcratch upon its ſurface, is ſufficient to break it. The firſt effect takes place when red-hot glaſs is dipped in water, or has water poured upon it. The drops of glaſs called Dutch Tears or Prince Rupert's Drops, furniſh an example of the ſecond kind. Theſe drops are made by letting melted glaſs fall into water: as their ſurface is but ſmall, and is of a ſpherical form, it is ſufficiently ſtrong to reſiſt the expanſion of the internal particles, and the preſſure of the external air, cauſed by the vacuum which is formed within; but, if the end of the drop is broken off, the reſiſtance ceaſes, and the glaſs drop, although very thick, is reduced into powder.

In ſome glaſs-houſes, the workmen ſhew glaſſes which have been cooled in the open air: on theſe they let leaden bullets fall, without breaking them. They afterwards deſire you to let a few grains of ſand fall on them; by doing which, the glaſs is broken into a thouſand pieces. The reaſon of this is, that the lead does not ſcratch the ſurface of the glaſs; whereas the ſand, being ſharp and angular, ſcratches it ſufficiently to produce the effect here ſpoken of.

which was covered with leather: by turning the ſcrew, ſo as to preſs againſt the middle of the plate, he could produce therein a very evident degree of curvature.

Firſt Operation. When the plates have been examined, in the manner already deſcribed, the firſt operation is, to make them thinner. For this purpoſe, one, or more, is placed upon a very even table of ſtone, or of thick wood: on this they are fixed, in a truly horizontal poſition, by means of a layer of plaſter in a rather liquid ſtate. A workman gets upon the glaſs, and treads it, ſo as to force the plaſter to ſpread itſelf evenly under the glaſs. Other plates, eighteen inches or two feet ſquare, and alſo in the rough, are fixed, by means of plaſter, upon flat pieces of wood or ſtone, of the ſame dimenſions as the plates themſelves; taking care (in order that the friction may not be too great) to place the ſmootheſt ſide outwards, if the rougheſt ſide of the other plates is to be firſt poliſhed, and *vice verſa*. When the plaſter is dry, theſe ſmall plates are put upon the others; and, upon the flat ſtone or piece of wood to which they are fixed, is laid another ſtone, for the purpoſe of increaſing the preſſure. This laſt ſtone is let into a frame of wood, which has a kind of handle at each corner: it may be made faſt to the other by the help of a little plaſter. Between the glaſſes is thrown water, mixed with ſand, or

with powdered grit-ſtone, which ſhould be finer, as the work advances. The workman, by moving the machine about by means of the handles, (which he paſſes from one hand to the other,) grinds the plates, by rubbing them againſt each other, ſo that thoſe which ſerve to poliſh the others become alſo poliſhed themſelves; but, being much ſmaller in ſize than the under ones, they are much ſooner ground ſmooth, and therefore require to be changed from time to time. At the beginning of the operation, as the ſurfaces are very irregular, the plates would be in danger of being broken by too great a degree of friction, if the machine were too much loaded; but, as the ſurfaces become more ſmooth, other flat ſtones, an inch and a half or two inches thick, are put between thoſe we have already deſcribed. The friction is of itſelf ſufficient to keep them together; they may, however, have pieces of cloth between them. A kind of ruler, laid on the plates, ſerves to diſcover what parts are moſt prominent, and require rubbing down.

The operation here deſcribed is a partial one, and is performed ſucceſſively in different parts of the plate, merely for the purpoſe of rendering it ſmooth; it muſt afterwards be made even.

Second Operation. Two workmen, one at each end of the table, drive the machine from one to the other, making it turn about, upon the plate, in

in all directions. As the work advances, machines of the ſame form, but larger in ſize, are employed. The poliſhing of the plates might be entirely finiſhed by means of theſe machines; but the one we are now going to deſcribe anſwers the purpoſe much more completely.

Third Operation. When the ſecond operation (which laſts two or three days) is finiſhed, the workmen (by means of plaſter) faſten upon a kind of table (of the ſame ſize as the fixed one) a plate of glaſs, as large as that which is to be poliſhed, and which has already been ground to the ſame degree of ſmoothneſs. This plate is laid upon the other, and to the wooden back or table is fixed a large and very light wheel, formed of a piece of thin wood bent into a circular form, and having a certain number of thin ſpokes, to which the rim is nailed. Between the wooden table and the wheel, ſquare pieces of thin ſtone are gradually added, in order to increaſe the weight, as the glaſs becomes poliſhed. Two workmen, by means of this wheel, puſh the table backwards and forwards, and cauſe it to turn about in all directions, taking care that water, with ſand in it, is often thrown between the plates *. By this means,

* We have obſerved, at thoſe parts where the ſand with which the glaſs is poliſhed falls, very conſiderable efflore￼ſcences;

means, the two plates at laſt acquire a perfectly even ſurface. When they have thus been ground on both ſides, in ſuch a manner that the ſurfaces are exactly parallel to each other, (which is diſcovered by means of rulers and proper levels,) they are not yet tranſparent, but have a whitiſh dull appearance on the ſurface, occaſioned by an infinite number of little ſcratches made by the ſand. They muſt ſtill undergo other operations, which we ſhall now deſcribe.

cences; they had the appearance and the taſte of bar[illegible] We believe that the glass (which is compoſed of barilla and ſand) is decompoſed, by the extreme diviſion of its parts, and the heat occaſioned by the friction made uſe of.

TO BE CONCLUDED IN OUR NEXT.

XLIX. *List of Patents for Inventions, &c.*

(Continued from Page 288.)

HEZEKIAH BEERS PIERPOINT, of New York, in North America, Merchant, at present residing in Surrey-street, in the Strand; for a new sort of oil, produced or extracted from certain vegetable substances, not heretofore used in this kingdom for that purpose. Dated February [illegible], 1799.

JOSEPH WATTS, of Yeovil, in the county of Somerset, Tanner and Glove-manufacturer; for tanning foreign and English kid, goat, sheep, and lamb skins, (or other skins usually tanned into gloves and mittens,) into leather fit for gloves and mittens, without lime and bran, in a shorter space of time, and with less expence and labour, than have ever yet been used. Dated February 5, 1799.

HUMPHREY JEFFREYS, of the town and county of Newcastle-upon-Tyne, Engineer; for an improvement applicable to bringing or conveying coals from the interior parts of coal-mines, or other mines; also for an improvement upon machinery for raising coals, ores, or other minerals, in the pit or shaft; also for an improvement in the manner of delivering coals, ores, or other minerals,

minerals, at the mouth of the pit or ſhaft. Dated February 12, 1799.

JOSEPH DALE, of St. Mary-le-bone, in the county of Middleſex, Muſic-ſeller; for improvements on the tambourine. Dated February 19, 1799.

SAMUEL SANDY HICKLING, of Birmingham, in the county of Warwick, Gentleman; for improving and beautifying certain veſſels and utenſils uſed for chemical, culinary, and various other purpoſes. Dated February 28, 1799.

JOHN LUCCOCK, of Morley, near Leeds, in the county of York, Wool-ſtapler; for a machine, upon hydroſtatic principles, to produce a very conſiderable mechanical power, applicable to all the purpoſes of a ſteam-engine, but without the uſe of fire, ſteam, or water-wheel. Dated February 28, 1799.

JOSEPH TIDMARSH, of the pariſh of St. Luke, Chelſea, Glazier and Painter; for an article which may be uſed alone, as a ſubſtitute for paint, or mixed with paints in general, for the purpoſe of enlarging their quantity, and reducing their price. Dated February 28, 1799.

GEORGE MEDHURST, of Battle Bridge, in the pariſh of St. James, Clerkenwell, Engineer; for a condenſing wind-engine, capable of being applied to all purpoſes in which either ſteam, wind, water, or horſes, are uſed. Dated February 28, 1799.

REPERTORY OF ARTS AND MANUFACTURES.

NUMBER LX.

I. *Specification of the Patent granted to* JOHN CURR, *of the Parish of Sheffield, in the County of York, Gentleman; for a Method of forming and making a flat Rope, intended to be used in drawing Coals, and other Minerals, and Water, out of Pits or Mines of any Kind.*

WITH A PLATE.

Dated Nov. 17, 1798.

TO all to whom these presents shall come, &c. Now KNOW YE, that in compliance with the said proviso, I the said John Curr do hereby describe and ascertain the nature of my said invention, and the manner in which the same is to be performed, used, and exercised, as follows; that is to say: The said flat rope may be formed by connecting two or more small ropes sidewise together,

together, by ſewing or ſtitching, lapping or interlacing them with thread, or ſmall rope, made of hemp, flax, or other fit materials, or with braſs or iron wire, in ſuch manner as to prevent their ſeparating from each other, and ſo as to cauſe them to exhibit, as nearly as poſſible, a flat form, or flat pliable rope.

The method to be taken, of ſewing or ſtitching theſe ropes together, may be effected by various ways; but the annexed plans of a machine, for the above purpoſe, will be found uſeful and expeditious; wherein Fig. 1. (Plate XIX.) ſhews the plat-form or ground plan: Fig. 2. a ſide view; and Fig. 3. a front view, of this machine. Take ſix, or any other plural number of ropes, S, (which ſhould be each of the circumference of about three inches,) of a length and number ſufficient for the depth and weight they are intended to lift; and, with the aſſiſtance of a man at the ſmall end of the long lever L, and the ſliding rod *m*, which commands the inſtrument *o*, pierce a round hole through the middle or centre of all the ropes, in a ſloping direction, with an inſtrument or needle about five-ſixteenths of an inch in diameter, if you ſew with rope or thread; if with wire, a ſmaller hole will be ſufficient. Then draw back again, by the aſſiſtance of the ſaid lever L, the piercing inſtrument *o*, and immediately draw the ſmall rope, thread, or wire *v*

(which

(which may be cut into lengths of eight or ten yards each) tight through the ſaid hole. Then, with the aſſiſtance of the lever K, and the chain *p p*, that works over the roller *a* and round the ſheeve *q*, draw the ropes the length of half a ſtitch through the ſide rollers *f, f, f, f*, (which are intended to ſqueeze the ropes very cloſe ſidewiſe together,) and the upper and lower rollers *g, g*, (which are intended to hold the ropes at even or equal height,) and then, by the moving of the lever R, another hole will be pierced in the oppoſite ſide of the ropes, through which hole the ſaid ſmall rope, thread, or wire *v*, muſt be tight drawn. The firſt pair of rollers *f, f*, [illegible] fixed a little wider than the ſecond pair, to give a more eaſy and gradual ſqueeze to the ropes ſidewiſe, obſerving that the lever K muſt again draw up the rope half a ſtitch farther, when the lever L will again be moved, to take another ſtitch, and ſo on until the rope is finiſhed, (as deſcribed by *r*,) from one end to the other; taking care to put a knot upon the ſmall rope, thread, or wire, at the ends, when you begin each length. The inſtrument *k*, which fixes upon the rope by ſcrews, is drawn along by the lever K until it reaches the ſheeve *q*; then it is unſcrewed, and moved forward again, and fixed near the rollers *t, t*, as often as occaſion requires. The rollers *t, t*, (ſhewn only in Fig. 2,) through which the rope is drawn after

it is ſewed or ſtitched, are intended to flatten the rope, and prepare it the better for uſe. The rollers O, O, ſupport the ſmall end of the long levers L and R; and the frame of wood N N N is fixed for the rollers to move upon. One pair of the ſide rollers *f*, *f*, that ſqueeze the ropes together, as well as the frame CC, in which they are placed, is fixed in the frame *d d*: the other pair, with the frame *c c*, (in which they work,) is moveable, to accommodate ropes of ſundry breadths; and the iron *h*, which is ſcrewed at both ends, regulates the moving ſide-rollers and their frame *c c*. The upper and lower ſqueezing rollers *g*, *g*, as well as the frame *b b*, in which they are placed, require a variety of ſizes of them, to ſuit the ſundry breadths of flat ropes that may be wanted, and require alſo to be held ſteady ſidewiſe, by means of the ſmall chain and rectifying ſcrews *w*, *w*, to prevent the rollers *f*, *f*, and *g*, *g*, from touching each other: theſe rectifying ſcrews and chain *w*, *w*, are ſhewn only on the platform, Fig. 1, as to ſhew them alſo on the end and ſide view would only ſerve to confuſe the drawing. The rectifying ſcrews *i*, *i*, and *u*, *u*, are to fix the frame, which contains the upper and lower ſqueezing rollers, at proper widths, to accommodate ropes of different thickneſſes. The collar and ſcrew *e*, which goes round the ſqueezing frame *c c*, is intended to draw and hold the frame

frame *c c* cloſe together, at the point near where the piercing takes place; and, in the part of the frame *b b*, over and beneath where the piercing needle or inſtrument goes through, a little hollow muſt be made, otherwiſe the hole ſo pierced will cloſe up, before the ſmall rope, thread, or wire, can be got through. *l, l, l, l,* are thimbles, with rectifying ſcrews, which move occaſionally, to ſuit the ſundry breadths of ropes, and guide the ſliding inſtruments *m* and *n*; and there is a double chain fixed to the working head of the long levers R and L, one of which chains is to ſend the inſtrument forward, and the other to draw it back again. The ſmall holes, marked o on the back frame N N N, are for fixing regulating ſtops for the long levers R and L. Fig. 6. ſhews a contrary view of the ſliding inſtruments *m* and *n*, and alſo of the aforeſaid double chain. By this mode of ſewing or ſtitching, the thread, ſmall rope, or wire, goes through the middle or centre of the rope, and, by taking the ſtitches very ſhort, is not much expoſed to wear. The correſponding capital letters in the plat-form, ſide, and end view, in the annexed plans, will ſufficiently ſhew and explain the mode of fixing up the wooden frame, to which the ſqueezing rollers and apparatus are annexed. If the rope is propoſed to be ſewed or ſtitched with thread or ſmall rope, it will be well to have it laid ſofter than ordinary by the rope-maker, and to fix a needle to the work-

ing

ing end of the thread or ſmall rope uſed for the ſewing, to guide it the better and more expeditiouſly through the hole of the rope, after it is pierced. To lap or interlace a rope (as diſtinguiſhable from ſewing or ſtitching) with thread or ſmall rope, or with braſs or iron wire, may be done by the hand, without any apparatus, excepting only that it would be well to draw it through a pair of rollers, after the lapping or interlacing is done, to flatten it for uſe. A view of Fig. 4, which ſhews the flat-form, and of Fig. 5, which ſhews an end view, will ſufficiently explain the method of thus lapping or interlacing. By this means, the ſmall rope, thread, or wire, is expoſed upon the outſide of the rope, and of courſe is more liable to wear, which ſeems to give a preference to the former explained method of ſewing or ſtitching. Having fully explained the nature of the new invention of manufacturing a flat rope, it will be proper to obſerve, that when it is applied to uſe, it muſt lap upon itſelf, in a niche or groove, that muſt be fixed upon the rope-wheel of the machine which draws the coals, or other minerals, or water, out of the pits or mines; and, by ſuch application, a great advantage will be obtained in the powers to be applied for lifting the minerals, as a counter-balance will be thereby procured, which, in deep ſhafts, is of conſiderable importance. In witneſs whereof, &c.

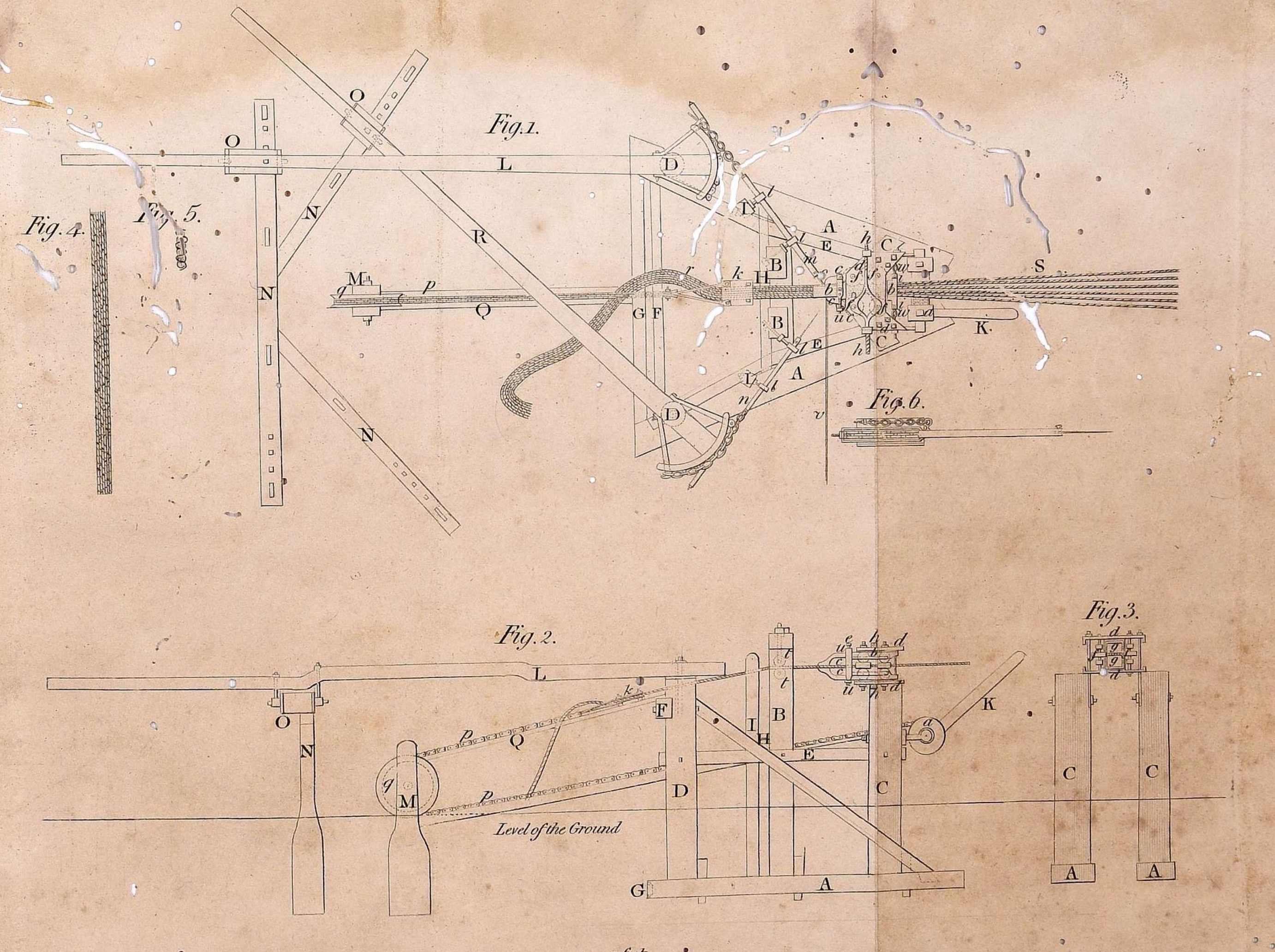


Fig.1.
Fig.4.
Fig. 5.
Fig.6.
Fig.2.
Fig.3.
Level of the Ground
1 2 feet

LI. *Conclusion of the Specification of Mr.* Bentham's *Patent for various new and improved Methods of working Wood, Metal, and other Materials.*

(From Page 320.)

VIII. *TURNING in a lathe.* In some cases, there may be a convenience in employing a double lathe, composed of two mandrils, like those spoken of under the article of boring; each mandril being furnished with a proportionably closing chuck, of one of the kinds spoken of farther on, under the head of *Adjustment and Steadiment,* the two mandrils being thereby adapted to lay hold of each of them; or, the face of the chuck being flat, the steadiment may be given by a degree of penetration, resulting either from general roughness, or from rows of pins, or ridges or scores, like those on a rasp or file, radically disposed. In this case, it will be convenient that one of the mandrils should be made to press up, towards the other, by a weight or spring, strong enough to steady the piece. In some cases, it may be convenient to give simultaneous motion to the mandrils:

drils: this may be done by furniſhing each of them with a cog-wheel, working in two ſimilar cog-wheels, fixed on to a ſeparate ſpindle. In other caſes, a pair of chucks, of either kind, may be fixed previouſly to each end of a piece to be turned; and theſe chucks may, inſtead of being afterwards fixed on the mandril, be furniſhed with only a plain centre, of the male or the female kind, at the back of each, adapted to the centre pins of a lathe. The piece may by this means be inſtantaneouſly applied to any ordinary lathe, and that without being penetrated, or ſo much as touched, by the centre pins of the lathe. For the more readily preſenting a number of ſimilar pieces in proceſſion to a turning lathe, the following contrivance may be employed: where a piece is to be ſupported between the centre pins of an ordinary lathe, or between the mandrils of a double lathe, then, if the piece be of any regular figure, prepare a moveable bed for it to lye in, in ſuch manner that the centre of magnitude of each end of the piece ſhall be in the direction of the centres of the lathe. Give the piece then whatever ſupport it requires in the lathe; and, having ſo done, move the bed out of the way, ſo much as is neceſſary to prevent its obſtructing the rotative motion of the piece; but let the bed be ſo fitted to the lathe, as that it may be inſtantaneouſly replaced in exactly the

ſame

ſame poſition, for the adjuſtment of any ſimilar piece. If the piece be ſquare or circular, that is, if a tranſverſe ſection of it, made at right angles to the axis, be a ſquare or a circle, let the bed be made in the ſhape of a V, the arms of which form a right angle; ſo that, by ſliding up and down, to and fro, from the centre of the centre pin, it may be made to ſerve for ſquare or circular pieces of various dimenſions, and that without any other variation than adjuſting the height of the bed to the diameter of the piece. A bed of this ſort I call a *preſenting-bed.* The turning a number of pieces exactly of the ſame figure, may be facilitated by enabling the tool to receive a more effectual guidance from the reſt. If the length of the piece to be turned comes within the compaſs of the breadth that can conveniently be given to the tool, then, having ready any tool adapted to the figure required, let there be a channel for the reſt, in which channel the tool may ſlide up towards the piece, till the work is finiſhed; a moveable ſtop being adjuſted on the tool, ſo as to prevent its being ſhoved too far. But, if the piece be ſo long as that the tool muſt, in order to enable it to compleat its work, be moved along the piece, provide a reſt extending the whole length of the piece, in which reſt, make along its whole length a channel, conformable to the general external figure (whether

ſtraight or curved) which the piece is to be of when finiſhed; no regard being had, on this occaſion, (for reaſons that will hereafter be ſeen,) to ſmall indentures or projections. Let there, moreover, be a block, with two equal round pins projecting from the underſide of it, each of them fitted into the groove of the reſt, ſo as to ſlide in it without ſhaking. In this block let the tool ſlide up to the piece, through a groove or mortiſe, with a ſcrew through the top of the mortiſe, to fix it at any part of its courſe, and with a ſtop or ſhoulder, to prevent its being advanced too far. The tool may, in that part of its edge which is to be firſt preſented to the piece, be adapted to cutting away the roughest part; in the other part, to the ſmoothing of the work; and theſe two parts of the tool it may be convenient ſhould be ſeparable from each other. Apply now this tool to one end of the piece, and, as the piece turns, let the tool advance along the channel in the reſt. The piece will thus receive its configuration, according to that of the channel, ſuppoſing no ſharp projection to be included in its figure. If, on the other hand, any ſuch projection is to be left, a ſtop muſt be provided for ſtopping the tool at that part of the reſt: at this period let the tool be drawn back, through its mortiſe, and, when it has paſſed the place of the projection, it may be advanced again up to its ſhoulder, and the

the operation continued as before. To finiſh any ſuch projection, provide, as before, at that part of the reſt, a fixed block, with another tool on it, ſliding up to the work through a mortiſe or channel; and ſo in caſe of a cavity, or any number of cavities, or projections. For turning long and ſlender articles, beſides the channel already deſcribed for the guidance of the tool, let there be on the other ſide a correſponding channel, in which moves a ſlider, ſimilar to the one employed for the application of the tool: to this ſecond ſlider fix a ſupport, which is to be made to keep pace with the tool, keeping only ſo much behind as not to touch the piece, except where it has already received its figure. Inſtead of a ſimple cutting tool, ſliding in a channel as above, a circular cutter may be employed, turning upon its axis; and, for hard ſubſtances, ſuch as hardened ſteel, or ſtone, or any other ſubſtances that are beſt wrought upon by grinding, may be employed grindſtones, laps, or any other of the inſtruments beſt adapted to the nature of the ſubſtance. If certain parts of the ſame piece, or the whole of it, be required, inſtead of being round, to be of any number of ſides, and yet of a figure correſponding to that of the channel in the reſt, keep the piece ſtationary in the lathe, inſtead of keeping it turning, and the ſides may be ſucceſſively formed by a ſimple cutter, like a plane or

 chiſel,

chisel, guided by the channel as before; each side being formed by one stroke, or by repeated strokes, according to the nature of the case. Or, instead of a cutter of the sort just mentioned, may be employed a circular cutter or grinding instrument, turning on a spindle which plays in a support, which support slides in the channel above spoken of. By the introduction of a dividing plate and index, the number of the sides may be determined at pleasure: in this way, similar polygons may accordingly be worked. Instead of guiding the tool in its motion along the piece, as above spoken of, by a fixed channel or otherwise, another mode is, to make the lathe itself, with the piece suspended in it, to reciprocate or traverse longitudinally, the tool remaining stationary: this longitudinal motion may be either straight, waved, or otherwise curved. A tool with a rotative motion may be equally applied to the cutting of screws, of all sorts and sizes, and in all variety of materials. For cutting a screw, or for cutting a channel or furrow in a spiral form, with respect to making the piece move on as it turns about its axis, according to the angle of the spiral, the modes already in use in screw-cutting may be employed: adapt the edge of a circular cutter to the shape of the thread or spiral channel, and adjust the spindle of the cutter to the angle of the spiral; give them a quick motion to the

the cutter, while the piece is turning gently round in the oppoſite direction, at ſuch a rate as to give time for the cutter to clear its way, and the ſcrew will be completely cut as the piece advances. The operation may, in ſome caſes, be facilitated, by employing, before or even inſtead of the above cutter, two thin cutters or ſaws, ſo adjuſted as that their kerfs ſhall meet, and thus take out an angular ſpiral ſlip entire, the whole length of the ſcrew. If the piece in which the ſcrew is to be cut be as yet in a rough ſtate, it may be brought to ſhape, and the ſcrew cut in it, at the ſame time; the cutter being ſo ſhaped as that, while one part of its breadth forms the ridge, another ſhall cut the furrow. For cutting taper ſcrews of all ſorts, and fuzees for watches, clocks, &c. circular cutters may very advantageouſly be employed: all you have to do is to make them advance to, and recede from, the axis of the piece, according as the taper or ſhape requires. If, while the piece rotates without advancing, you preſent to it, at the proper angle, a ſhort ſtraight knife, guided by a channelled reſt, upon the principle of that above deſcribed, or otherwiſe, the combination of the two motions, the rotatory with the longitudinal, will produce the drawing ſtroke neceſſary for cutting cork, and other ſoft and elaſtic ſubſtances. In this caſe, that the buſineſs may be done at one ſtroke, ſo that the

6 tool

tool ſhall finiſh as it goes, the rotative motion of the piece ſhould be derived from the longitudinal one of the knife; and the knife ſhould be long enough to apply itſelf, during the whole courſe of the operation, to the whole of the length of the piece.

IX. *Adjuſtment and ſteadiment.* Throughout the whole ſyſtem of the operations above delineated, the accuracy of the work, as well as the expedition with which it is performed, will depend, in a great degree, on the exactneſs with which the piece is placed in the poſition in which it is to undergo the action of the tool, and the firmneſs with which it is fixed there, eſpecially where a number of pieces are to receive ſimilar configurations; in which caſe, the exact ſimilarity will depend on the exactneſs with which their reſpective poſitions ſucceſſively coincide. One way of adjuſting the poſition of a piece would be by lines traced on its bed, and this is the only mode which is of a piece with common practice; but, for working to ſimilar ſhapes, a much more ſuitable and advantageous way is, to prepare ſtops and ſupports, ſo placed in the bed or bench as that every one of a number of ſimilar pieces, when applied ſucceſſively againſt theſe ſtops, ſhall unavoidably have been brought into the ſame poſition. Beſides the great advantage which, when the ſimilar pieces are numerous, is gained in point

point of expedition, the accuracy of the work is by this means rendered independent, in good meaſure, even of attention, and altogether of dexterity: the contrivance and arrangement of theſe ſtops, according to the figure and dimenſions of the piece to be worked, as well as the moſt eligible modes of ſteadying the piece in its poſition, are what an experienced mechanic can be at no loſs to accompliſh. For ſome purpoſes, I find it convenient to have pins or ſtuds, projecting from tongues, fitting in grooves cut in the bed or bench, ſo as to be ſtationable by means of ſcrews or wedges. Sometimes it will be convenient to have the ſtops fixed for only one end and one ſide of the piece, while the oppoſite ones are made moveable: ſuch a moveable ſtop may then conſiſt of a ſcrew or wedge, acting ſo as to open for the purpoſe of receiving the piece, and cloſe in again, with a force ſufficient to hold the piece ſteady enough to reſiſt the action of the tool.

How to preſent the ſame determinate parts of a number of ſimilar pieces ſucceſſively to the action of a tool. Firſt, Where the intended ſtations are diſpoſed along the length of a piece. In this caſe, fix the piece on a ſliding-bed, in ſuch a manner as to be moveable in the direction of its length: let the ſliding-bed be furniſhed with a ſtop, in the form of a pin or bolt, projecting, for example, from the ſide, to be inſerted, or to drop of itſelf,

itſelf, into holes or notches in the bench, one for each of the poſitions required. Or, inſtead of being made in the bench itſelf, theſe holes or notches may be made in a piece of wood or metal, moveable in a groove, or otherwiſe, along the courſe which the ſliding-bed is to take. In this way, ſimilar pieces may, at equi-diſtant or otherwiſe correſpondent points of their reſpective lengths, be expoſed to the action of a borer, for example, a ſaw, a file, or any other tool adapted to the hole, inciſion, or mark, which they may be intended to receive. If, as in the above deſcribed method of making oblong mortiſes, for example, it be required that, when arrived at any one of the propoſed ſtations, the piece, inſtead of being abſolutely fixed at that ſtation, ſhould, in order to receive a perforation or inciſion ſo much the longer, move to and fro within certain limits, the purpoſe may be effected by giving a correſpondent extent to the notch or hole, within which the pin or other projection is, for this purpoſe, to be allowed to traverſe.

Secondly, Where the intended ſtations are diſpoſed along the tranſverſe dimenſion of the piece. In this caſe, the ſimpleſt way, if circumſtances will admit, is to lay the piece ſucceſſively upon its different ſides, its poſition, in reſpect of its length, being all the while preſerved by ſtops applying themſelves at each end; but, under

under other circumſtances, particularly in the inſtance of circular pieces, or many-ſided pieces approaching to circular, it may be more convenient to give the piece ſuch a mode of ſupport as may allow it to turn freely upon its axis, for the purpoſe of being connected with a dividing plate; into which a ſtop may be inſerted, by means of holes correſponding to the ſtation required; thus, the nave of a wheel, for example, may be ſupported by puppets projecting from a ſliding bed, while the mortiſes are cutting in it for the ſpokes; thus again, a pillar, for example, may be ſtopped for fluting, or a rough log, for being formed into a regular polygon, ſupported on the ſlider of a ſaw-frame.

How to hold ſucceſſively, between two ſupports, pieces of various dimenſions, in ſuch manner as that the middle of each piece ſhall ſucceſſively be adjuſted to the bed in the ſame poſition. For example, I make two oppoſite ſtops or ſupports moveable towards each other, and connected in their motions, in ſuch manner as that one cannot advance, without the other advances towards it an equal diſtance in the ſame time. If, inſtead of the middle, it be any other proportionate part that requires to be brought into a certain poſition, any ſuch variation of the effect may be produced, by only adjuſting the ſimultaneous motion of the ſupports, according to the proportion required;

 ſuppoſe,

ſuppoſe, for example, one of the ſupports is made to receive a motion always twice as great as the other; then, whatever be the breadth of the piece which is held between them, the imaginary line, dividing that piece into thirds, will be brought to the ſame poſition on the bed. A number of pieces may ſucceſſively be held breadthwiſe in this manner, upon a ſliding-bed, for the purpoſe of being advanced, for example against a ſaw, in order, each of them, to receive an inciſion in the middle, or in any proportional part, in order to be formed into a tenon at the end; thus again may a number of ſuch bars, of ever ſuch different breadths, be ſucceſſively brought into poſitions, in ſuch manner that the middle line of each ſhall coincide exactly with the centre or point of interſection of the ſquaring croſs. (See above, article *Mortiſing*.) If the piece require to be adjuſted depthwiſe alſo, then another ſuch pair of ſupports may be made to embrace it in that direction; thus, for example, a number of pieces, of various dimenſions, may each of them, at the middle or any other given part of either of its extremities, be expoſed to the action of a borer. A third pair of ſuch proportionally cloſing ſupports may, by embracing the piece endwiſe, compleat the ſimilarity of adjuſtment in all directions. The buſineſs of making the oppoſite ſtops move to and from each other, as required, is what may be accompliſhed in any

any one of a variety of ways; by two ſcrews, for example, turning in concert in fixed nuts, pointing towards each other; or by one double ſcrew, of the ſort called a right and left handed ſcrew, on which two nuts, one on the right-handed the other on the left-handed part, are made to approach towards or recede from each other, by turning the ſcrew one way or the other. I have never heard of the threads on ſuch a ſcrew being made any otherwiſe than of an equal inclination, the nut on the right handed part moving conſequently the one way, as far as the nut on the left handed part moves the other way; but it is plain, that by a difference in the inclination of the two threads, the nuts may be made to move in different proportions, and that according to any difference that may be required. Wedges acting againſt ſupports ſtationed on each ſide a piece, may, by being advanced equally and ſimultaneouſly, be made to produce the ſame effect; the lengths of the wedges, and the quantities of their reſpective longitudinal advancement, being always made equal, the proportions in which they reſpectively cloſe in upon the piece, will be regulated by their reſpective breadths or thickneſſes. If it be required that the ſame wedge ſhall move a ſupport backwards as well as forwards, the connection muſt be effected in ſuch manner as not to impede the

 ſliding,

fliding, for example, by a dovetail or T-fhaped tongue and groove: in fome cafes, the effect of a wedge may be produced to more advantage, by the application of a pin to an inclined flit. Where the motion to-and-fro of thefe fupports is to be extendible to greater lengths, the effect may be produced by two racks, moved parallel to each other, by a common pinion, or cogged wheel, placed between them; one rack being on one fide the axis of the pinion or cogged wheel, the other on the other fide. Where the piece muft, for example, on account of its great length, be held by feveral fuch clofing fupports, fituated at different parts of its length, matters may eafily be ordered fo that thofe fupports fhall all of them be put in motion at once. If, for this purpofe, wedges or levers be employed, a fimple bar, connected with thefe feveral wedges or levers, will produce the fimultaneity required. If fcrews are employed, a fmall wheel to each will enable all to be turned at once, by a racked bar. In this cafe, any proportional difference required to be made in the advancement of the fupports, may be accomplifhed, either by a difference in the diameter of the cogged wheels, by which the fcrews receive their rotative motion, or by a difference in the inclinations of the threads of the fcrews. Thus, by different fcrews, unequal motions may be given to any number of fupports, although

although their reſpective motions be received ſimultaneouſly, and that from one and the ſame bar. Thus, by means of wedges moving in concert, or ſcrews, or racks, not only may pieces of any ſhape be preſſed in as many parts at once as may be required for any purpoſe, but the buſineſs of ſimple adjuſtment, without preſſure, may be effected in a parallel or any other direction, by a ſimultaneous motion of ſtops or ſupports. So a bench, for inſtance, may be raiſed at once by means of ſupports, in ſuch number, and ſuch ſituations, as to inſure its poſition in a horizontal direction, or any other. So, for example, the guides uſed to the ſawing apparatus may be adjuſted according to the breadth of the piece to be ſawed, and thus the borers and other tools may be advanced, to act ſimultaneouſly on the piece.

How to make any number of ſupports move equally to and from a centre. For this purpoſe arrange, in a circular ring, as many ſcrews as you pleaſe, all pointing towards the centre, and furniſhed each with a ſmall cogged wheel, ſo that a circular cogged wheel, bar, or ring, acting at once upon all thoſe wheels, by being moved one way, makes all the ſcrews advance towards the centre, and, by moving the other way, makes them recede from it. Upon this principle I have made chucks for turning lathes, with different numbers of ſupports, ſo as to embrace a circular or polygonal

piece

piece on all fides at once, and that in a fituation exactly concentric with the axis of the mandril: I have alfo produced the fame effect by a circular bar, or ring of wedges, acting upon the outer ends of the fupport. When any number of pieces are to be put together in a circular form, for inftance, the component parts of wheels, the ftaves of cafks, &c. a contrivance of this kind may be as ufeful to bring the parts together, by uniform preffure into form, as to hold them in that form afterwards, for the purpofe of being turned or otherwife worked. It is plain that all thefe contrivances, for preffing and laying hold of the outfide of a piece by contraction, may be equally adapted to the acting on the infide of a hollow piece by diftenfion. In this way, a chuck may be made an univerfal chuck of the male kind, as well as of the female. A chuck, on this principle, may be made to take in pieces of as great a difference in diameter as can ever be required. For this purpofe, the fupports in queftion fhould be in the form of fliding bars, moving in grooves or channels cut in the face of the chuck, and pointing in the form of radii towards the centre: thefe fliding bars may themfelves be flufh with the face of the chuck, and, when preffed up, may extend as near to the centre as their breadths at that end will admit; at which part too they may be tapered away, for the purpofe of

of being enabled to cloſe in upon the ſmalleſt piece. Outwards, theſe ſliding bars may be enabled to extend as much beyond the chuck as the dimenſions of the pieces to be held may require. For laying hold of a piece, of any ſize, from the ſmalleſt to the greateſt to which the ſliders can extend, let them be furniſhed, throughout their whole length, with ranges of equally diſtant pin-holes: then, for ſupports to the piece, inſert ſtout pins into ſuch of the equi-diſtant holes as correſpond the neareſt to the dimenſions of the piece, and, on giving motion to the ſliders, the piece will be embraced as required. For many purpoſes, a chuck of a more ſimple conſtruction may ſuffice: it may be furniſhed, on its face, with one pair only of equally moving ſupports; eſpecially if the ſupports are furniſhed each with a pair of equi-diſtant and ſimilar horns, ſo as to ſupport the piece at four points. For other purpoſes, there may be two pair of ſupports, moving each pair ſeparately towards the centre, and at right angles to each other.

X. *Advancement, viz. of the piece to the tool, or of the tool to the piece.* For the caſe where the motion by which the work is performed is of the reciprocating kind, inſtructions have, under the head of *Sawing by a reciprocate motion*, been given by reference to preſent practice. When the motion is of the rotative kind, though the advance-

advancement may be performed by hand, yet regularity may be more effectually insured by the aid of mechanism. For this purpose, one expedient is the connecting, for instance, by cogged wheels, the advancing motion of the piece with the rotative motion of the tool: another expedient is, employing a power so as to gain purchase; in which case, the facility of insuring regularity will be according to the quantity of purchase gained. For short distances, this may be done commodiously enough by a lever or a screw; but, where the advancement is to have a long range, the rack and pinion is more convenient; the rack, for example, being fixed to the sliding bed, in a direction parallel to that of its motion, and the pinion which moves it turned by a winch. Or, instead of the action of the hand, a weight may be employed; or, for a very short space, a spring.

XI. *Clearance, viz. clearing away the chips or other abraded matter.* In some instances, provision is made for this object in the configuration given to the tool itself, (see article *Boring*;) in others, separate contrivances may be requisite. After boring, sawing is the operation which, from the nature of the tool, is most exposed to the inconvenience of clogging: this, therefore, appears to afford the fittest example of the expedients that may be employed for the purpose of clearance.

Whether,

Whether, even in this caſe, any expedient for this purpoſe, will be worth applying, will depend upon circumſtances, *viz.* upon the ſhape and magnitude of the ſpace between the teeth, and upon the quality of the ſubſtance ſawed. Where a ſlight power is ſufficient for the purpoſe of clearance, it may be afforded by a blaſt of air. Any workman will know how to apply the nozle of a pair of bellows, to blow, for this purpoſe, againſt the teeth of the ſaw: the bellows, it is evident, may be played either by the power that works the ſaw, or by any other power, as convenience may dictate. In caſes where air would be ineffectual, as in the inſtance of a wood abounding with turpentine, or any other adheſive roſin, a ſolid inſtrument muſt be employed, to perform the office of a bruſh, not that it is neceſſary that the ſubſtance of it ſhould, as in a bruſh, be flexible. Of this clearing tool, the form may be that of a thin cogged wheel; the ſpaces more extenſive than the cogs; the poſition tranſverſe to that of the ſaw, and ſo near as for the cogs of the wheel to enter between tooth and tooth of the ſaw; the motion derived from, and connected in ſuch manner with, that of the ſaw, that not only each cog ſhall paſs between tooth and tooth of the ſaw, but each tooth of the ſaw between cog and cog of the wheel; and, whether the ſawing apparatus be of the rotary or reciprocating kind,

kind, the form of the clearing tools may be ftill the fame. As to the derivation of the proper rotative motion of the clearing tool, from the rotative motion of the circular faw, or from the reciprocating motion of the reciprocate faw, it need not be particularized, being one of the moft common operations in millwork. Where the faw, being of the rotative kind, works above the bench, the clearing tool, in order to be out of the way, will naturally be placed below the bench. Where the faw is of the reciprocating kind, as fome of the teeth come out on one fide, (fay the upper fide of the piece,) others on the other, (fay the lower fide,) there muft be two fuch clearing tools, one above the piece, the other below it. It follows, that for the faw to have all its teeth cleared in this way, the length of the faw muft be fuch as that, partly on one fide partly on the other, all the teeth fhall come out of the piece, for the purpofe of meeting the action of the clearing tool. If the rotation of the clearing tools be produced immediately from the reciprocating motion of the faw, it will be vibratory, turning one way as the faw afcends, and the oppofite way as the faw defcends; by which means, the brufh will pafs and repafs between the teeth, within the period of fuch reciprocation of the faw. In the cafe of the reciprocating faw, inftead of the circular fort of clearing tool,

tool, may be employed a longitudinal one, in form of a rack or cogged bar, placed in front of the ſaw; the cogs alternating with the teeth of the ſaw, and ſweeping the ſpaces between them, in the manner of a comb: upon the arrival of the ſaw at the greateſt height, one of theſe combs clears the upper half of it, as, upon the deſcent of the ſaw to its greateſt depth, another does the lower half. The accuracy with which, in all theſe ſeveral caſes, the projecting parts of the clearing tool adapt themſelves to the ſpaces between the teeth of the ſaw, inſtead of running foul of the teeth themſelves, will depend upon the nicety of the connection between the motion of the tool and the motion of the ſaw, and need be no greater than what is commonly exemplified in mill-work.

The ſeveral modes of working above ſpoken of are the fruit of my own invention, matured more or leſs by my own practice. The deſcription I have given of them is ſuch as, according to the beſt of my judgement, would be ſufficient to enable any man that choſe it to put them in practice to advantage. In ſome of the inſtances, the contrivance is no more than what any intelligent mechanic, converſant in the particular branch of work which it is calculated to facilitate, may, by help of theſe inſtructions, be able to execute for himſelf, for the purpoſe at leaſt of that particular

branch of work. In others, especially where the invention is such as to comprise a new and entire machine, the assistance of a millwright or engineer by profession, whose business implies an acquaintance with machinery in general, may require to be called in. These several inventions I accordingly claim the exclusive right of exercising, and that in all the variations of which they are susceptible, and in respect of all sorts of materials to which they are applicable, saving such variations in which, and such materials on which, they may have already been practised by others without my knowledge. As to the mode of giving motion to any of the above machines, in addition to the modes in common use, one may be the putting the machine, if not too bulky, into a carriage, and deriving the power from the rotation of the wheels on which the carriage runs: in this way, besides the advantage of portability, the power of horses, or other beasts of draught, may be applied, at an expence less than that of erecting a horse-mill. In witness whereof, &c.

LII.

LII. *Specification of the Patent granted to Mr.* JOSHUA COLLIER, *of Weſt-Square, in the Pariſh of St. George, Southwark, Broker; for a Chemical Proceſs for freeing Fiſh-Oils from their Impurities in point of Smell, Taſte, and Colour; and improved Strainers for Oils and other Liquids; with other Inſtruments for aſcertaining their Qualities, and aſſiſting their burning.*

WITH A PLATE.

Dated Dec. 13, 1798.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE, that I the ſaid Joſhua Collier, in compliance with the ſaid proviſo, do hereby deſcribe the nature of my ſaid invention, as follows; namely: The machines are illuſtrated by the drawings hereunto annexed, together with their reſpective references. The chemical proceſs is performed as follows; to wit: I put a quantity of any ſpecies of fiſh-oil, or mixture of different ſorts of fiſh-oil, into any convenient veſſel, which I heat to the temperature of one hundred and ten or one hundred and twenty degrees of Fahrenheit's ſcale; I then add, of cauſtic mineral alkali, (of the ſpecific gravity commonly deſcribed as 1,25 or one and twenty

twenty five hundredths, or of such ſtrength that a phial containing one thouſand grains of diſtilled water will contain one thouſand two hundred and fifty grains of theſe leys,) a quantity equal to four parts to the one hundred, by weight, of the quantity of the oil. I then ſtir or agitate the mixture, and leave it to ſtand a ſufficient time for the ſalts and ſediment to ſubſide. It is then drawn off into another veſſel, containing a ſufficient quantity of freſh burnt charcoal, finely powdered, or of any other ſubſtance poſſeſſing antiſeptic properties, in a powdered or divided ſtate, with an addition of a ſmall proportion of diluted ſulphuric acid, ſufficient only to decompoſe the ſmall quantity of ſaponaceous matter ſtill ſuſpended in the oil, which will appear by the oil becoming clear at the ſurface. The contents of this veſſel are alſo agitated, and the coal, ſaline, and aqueous particles, left to ſubſide; after which, the oil is paſſed through proper ſtrainers, hereinafter deſcribed, and is thereby rendered perfectly tranſparent and fit for uſe. The principle of my improved ſtrainers or filtering machines, by which, as far as reſpects them, I deem myſelf entitled to the excluſive privilege ſecured by the ſaid patent, conſiſts in the means applied to combine hydroſtatic preſſure (which encreaſes as the perpendicular height of the fluid) with the mode of filtering *per aſcenſum*, thereby procuring the new and peculiar

peculiar advantage, that the fluid and its ſediment take oppoſite directions, and alſo, in whatever is new in the conſtruction of my machines herein deſcribed. It cannot but be ſeen, that a paſſage for the air, more free from objection than any hitherto adopted, is here contrived in thoſe deſigned for domeſtic purpoſes, Fig. 1.; and alſo, that the eaſy means of emptying their ſediment, facilitates the operation, and renders their uſe perfectly ſatisfactory to the moſt minute obſerver. A great advantage attending this invention is, that the dimenſions of the chamber in which the ſediment is received may be varied, while the filtering ſurface remains the ſame. To adapt theſe machines, not only to the purpoſes of families, workhouſes, hoſpitals, public charities, the navy, or the merchant ſervice, but alſo, to all the purpoſes of oil-men, of diſtillers, of the laboratory, the brewery, &c. chambers of various capacities muſt be provided for the ſediment and precipitated matter. With reſpect to the oil trade, the ſpace required is very great, eſpecially for ſpermaceti or Brazil bottoms. In the various proceſſes of the laboratory, no limits can be fixed, but all dimenſions will be occaſionally required. In diſtilleries and breweries, they may be ſmaller in proportion; and, in thoſe deſigned for water, and for domeſtic uſe, a very ſmall chamber will be ſufficient. When water is to be ſweetened, or freed from any putrid or noxious particles it may, from

from whatever caufe, contain, it paffes, in its way to the filtering-chamber, through an iron box, or cylinder, letters L M N O, in Fig. 1, containing charcoal finely powdered, or any other antifeptic fubftance, infoluble in water; which charcoal, or other fubftance, is forced clofely into the box by any mechanical power; after which, the water is made to pafs through it by the hydroftatic preffure, through a tube of any fufficient height. This box has two apertures, to receive and deliver the fluid, and thefe are opened or clofed by cocks or fcrews, at P and Q, or any other method ufed for fuch purpofes; and, being affixed to the machine by other fcrews, or fcrews and collars, may be eafily detached from the fame. Thus, whenever the charcoal begins to lofe its antifeptic properties, the box is removed, and heated till it is red-hot, by which means, the foreign matter efcapes through the fmall apertures; after which, the box is left to cool, and the charcoal becomes fweet, pure, and equally fit for ufe as at firft, though the procefs be ever fo often repeated.

Fig. 2. is a machine or contrivance for ftraining oil from the bottoms, in the manner defcribed in the references.

I further claim, by virtue of this patent, the exclufive privileges arifing from the invention of filtering machines, in the form or forms of ftills, in which charcoal may be repeatedly burned,

burned, after any fluid ſubſtances have paſſed through it, either for the purpoſe of freeing them from putrid or noxious particles, or of diſcharging their colouring matter; which filtering ſtills are ſo contrived, that the fluid may paſs through in any quantity, without diſplacing the charcoal, as in Fig. 3. The part of the fluid remaining interſperſed among the charcoal, may be driven over by a proper degree of heat, and be employed for many inferior purpoſes of the arts and manufactures. Laſtly, the heat may be raiſed, ſo as to purify the charcoal, as has been before deſcribed in the machines for filtering water, or other fluids, for domeſtic purpoſes. The flue of the ſtills is ſo conſtructed, that water may be employed to cool them, without the loſs of time requiſite for their gradually parting with their heat to the ſurrounding atmoſphere, ſo as to be fit for a ſubſequent operation.

My inſtruments for aſcertaining the comparative qualities of oils, depend in part on the principle of their ſpecific gravities; ſpermaceti oil, contraſted with other fiſh oils, being as 875 to 920. For this purpoſe, I uſe a glaſs-veſſel, of any convenient ſhape, furniſhed with a bubble, alſo of glaſs, and a thermometer. If the oil is pure, this bubble ſinks, when the mercury riſes to a certain ſtandard, by the application of the hand, or any other heat, to the veſſel containing the oil. If the ſpermaceti oil is impure, the bubble will ſtill

float, though it is of the temperature required, and the degree of impure or foreign matter will be ſhewn, by the ſcale of the thermometer, at which the bubble ſinks. To determine what tendency oils uſed for burning have to congeal in cold weather, I put equal quantities of nitre and ſal-ammoniac, finely powdered and mixed, into a phial of thin glaſs, or any other convenient veſſel, containing rather more than ſufficient water to diſſolve them; or I put any other freezing mixture into ſuch veſſel: I then immerſe a thermometer therein, and let a ſingle drop of the oil under experiment fall on the outſide of the veſſel, where it immediately congeals. As the cold, produced by the mixture, gradually ceaſes, it is eaſy to obſerve, by the thermometer, at what point of temperature the oil becomes fluid, and runs down the ſides of the glaſs. In witneſs whereof, &c.

Explanation of the Figures.

(See Plate XX.)

Fig. 1. A, the ciſtern, into which the water, or other fluid to be filtered, is put. B B B, a tube, opening into the bottom of the ciſtern A, and bent along the bottom of the machine, conveying the fluid into C C, the filtering chamber, which is covered with leather bound down round its circular rim, and through which leather the water is percolated. D D, the baſon, riſing above the level of the chamber, and receiving the filtered

filtered liquor. E, the ſpout by which it runs off, into a pitcher or other veſſel. F, another ſpout, furniſhed with a cock, to draw off the foul water from the chamber, when neceſſary. GGGG, the air-tube, which begins above the level of the chamber, is covered with a button, which ſaves the leather from being cut, and has a ſmall lateral aperture for the air to be carried off. This pipe paſſes along the bottom, and up the ſide, and, riſing above the level of the water in the ciſtern, is there cloſed, except a ſmall lateral aperture, through which the air eſcapes. H, a guard or rim, with croſs bars put over the leather, to keep it from being forced up by the water. It is faſtened down by means of two notches, on oppoſite ſides of the guard, by which it locks into two ſtaples rivetted into the bottom of the baſon. I, the lid, ſliding down to cover the water from duſt, and ſuſpended at pleaſure by means of K, K, two ſprings on each tube, for that purpoſe. LMNO, a cylindrical box, containing charcoal, which is connected with the above, by means of the tube P, and a continuation of the tube B. LM, the water-tube B continued below the charcoal apparatus, ſo that the fluid may paſs through the ſame into the cylinder at Q, from whence it enters the chamber at P, ſo as to be filtered through the leather, as before deſcribed. R, R, collars, which may be unſcrewed at pleaſure, ſo as to detach the charcoal apparatus, when the charcoal requires to

 be

be purified by heat. S, S, two cocks, to direct the fluid through the charcoal cylinder, or immediately into the filtering chamber.

Fig. 2. A, a tube or ciſtern, containing the oil to be filtered, and ſupplying a tube of ſufficient height for the hydroſtatic preſſure to operate. B B, a main tube, of wood, tin, leather, or cloth, to which any number of bags C, C, C, C, of the ſize and ſhape of corn ſacks, or any convenient ſize and ſhape, may be connected; theſe are bound to ſtraight double-iron bars D, D, D, D, furniſhed with a hinge at one end, and a ſcrew at the other, by opening which the bags may be emptied. E E, a trough underneath, made to receive the filtered oil.

Fig. 3. A, a funnel, caſk, or ciſtern, into which the fluid is put, which paſſes down B, a tube fitted into the ſame, through which it enters C, an iron ſtill, full of finely-powdered and ſifted charcoal, through the head of which the fluid paſſes into any receiver. D, a fire-place, of any conſtruction, to drive over the fluid remaining interſperſed among the charcoal, and alſo to purify the charcoal by an increaſe of temperature, when required. E, a cock to let water into the flues, to cool the apparatus for a ſubſequent operation.

We are deſired to ſay, that the machines herein deſcribed may be had (with numerous improvements) of Mr. Thomas Collinſon, (agent for the patentee,) No. 47, Leadenhall-ſtreet.

LIII.

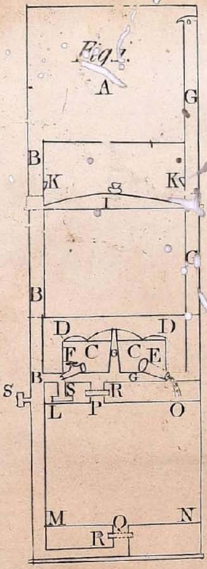


Fig. 1.

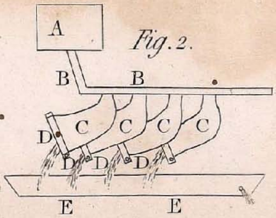


Fig. 2.

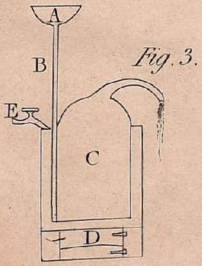
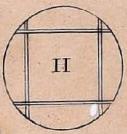


Fig. 3.



LIII. *Specification of the Patent granted to Mr.* MAURICE CRAWFORD, *of Edinburgh, Copper-ſmith and Brazier, for his new Method of tinning Copper, which will laſt ten Times longer than the Method now uſed.*

Dated Auguſt 10, 1770.—Term expired.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE, that I, in obedience to, and in compliance with, the ſaid proviſo, have given a deſcription of my ſaid invention, as I hereby give the ſaid deſcription, in manner following; *viz.* The copper muſt be wrought in the common way, till it is ready for the firſt pickling: then pickle it off in the common way. After which, it muſt be freezed in the inſide, upon ſtakes cut as rough as a coarſe file, or any other method of freezing, which opens the pores of the copper, and makes the tinning penetrate. That being done, the copper muſt be pickled for the laſt time, and ſcoured clean on both ſides. Then tin it with ſal-ammoniac and grain tin; and, when properly tinned with that, take

take a metal compounded of grain-tin and zinc or ſpelter, in the following proportions; *viz.* to each pound of grain-tin, add one pound and a half of zinc or ſpelter, or any other metal of equal wholeſomeneſs and hardneſs: with this metal and ſal-ammoniac, tin it well over, and, when ſo tinned, ſcour the inſide clean, and rough-planiſh it on a bright ſtake. Then rub the inſide with chalk and water, ſo that the tin comes clean: planiſh and ſmooth it hard, ſo as to bring it to a gloſs. All pieces of work that require to be tinned on both ſides, ſuch as ladles, ſkimmers, &c. muſt be freezed on a cut ſtake, with a cut hammer, or in ſuch manner as before mentioned, and dipped in the melted metal, and finiſhed as before mentioned. All nails muſt be freezed and dipped likewiſe in the metal. Which deſcription and method of working I hereby declare to be the method invented by me, and for which I obtained his Majeſty's letters patent. In witneſs whereof, &c.

LIV.

LIV. *Deſcription of a new-invented Fire-Ship, (to be rowed by Steam,) that will conduct herſelf into an Enemy's Port, without any Perſon being on Board; with an exact drawing of the Model, as laid before the Admiralty in October,* 1796. *By Mr.* Edward Thomason, *of Birmingham.*

WITH A PLATE.

SOME naval officers having informed me that fire-ſhips were of no uſe, in conſequence of the very great danger to which the lives of thoſe who conducted them were expoſed, I thought of the poſſibility of inventing ſome machinery, aſſiſted by ſteam, that ſhould row the veſſel, and conduct her to any given place, without any perſon on board. The firſt thing I had to contrive, was the mode of applying the oars: it ſtruck me that the moſt ſimple method would be, by fixing them to one or more fly-wheels, on each ſide of the veſſel. Convinced this would anſwer, my next conſideration was, the machinery neceſſary to be attached,

attached, fo as to move the rudder, at any given time, whichever way might be required. This compleated, a third movement was wanted, to make the veffel fet fire to her combuftibles, at the very time fhe arrived among the veffels in the enemy's harbour; this I at laft invented to my entire fatisfaction. The conftruction of which fhip I fhall now defcribe, after obferving, that the machinery is placed *on deck*, in the figure, that it might be more intelligible.

A B C D, (Plate XXI.) Fig 1, is the veffel; (any one unfit for fervice would do.) E F G, the fteam-engine, which produces a rotative motion, by means of the crank H. I, I, are the arms of the crank, which pafs through the upright fockets K, K, wherein the fpindle of the crank moves. L, L, are the fly-wheels, fixed on each end of the fpindle of the crank; the arms of which, N, N, N, N, are the oars, each paffing through the furface of the water, at every ftroke of the fteam-engine. As the wheels are placed perfectly true, and oppofite to each other, the oars muft fall on the water, on each fide of the fhip, at the fame inftant of time; which compels the veffel to keep a rectilineal courfe, if the rudder is kept in a ftraight pofition. O, is a one-tooth wheel, fixed on the fpindle, to affift the wheel P in moving the wheel Q; which wheel Q, for every

ftroke

ſtroke of the engine, moves the ſpace of one tooth; and, as there are twenty teeth in the wheel Q, the engine muſt make twenty ſtrokes for every revolution of this wheel. On the back of this wheel is firmly ſcrewed another wheel R, which has only one tooth, as at *c*; which tooth, for every revolution of the wheel Q, or for every twenty ſtrokes of the engine, moves the wheel S one tooth; ſo that, when the wheel Q has made one revolution, the tooth N° 20, in the wheel S, will be the ſpace of one cog lower, and the tooth N° 40 in its place, which will point out that the engine had made twenty ſtrokes; the tooth N° 20 being below the knob *z*, which knob is placed to regulate the fixing of the wheel S, at the time of ſetting the machinery: this wheel counts to the number of 400; and, if a third wheel was added, of twenty teeth, it would count to 8000. However, to avoid its appearing too complicated, I have only placed two numbered wheels in the drawing, which, in fact, would be as many as would be wanted to be uſed in moſt caſes. *a*, *a*, are two ſteel ſprings, whoſe butts are ſcrewed to the frame, on the other ſide of the wheels, and whoſe points fall into holes of the wheels R and S, to prevent them from moving more than one ſtroke at a time. T, is an iron plug, which ſcrews into any tooth of the

the wheel S, there being a ſcrew hole in each tooth to receive it: it appears now to be ſcrewed in the tooth N° 60. This plug T is to move the lever V W, which lever moves on a centre at g; therefore, at the ſixtieth ſtroke of the engine, the plug will force down upon the lever V W, which raiſes up the end near the pulley X, to which end there is a cord, that paſſes under the ſame pulley X, and over the pulley Y, and is faſtened to the arm of the rudder, at Z. It is therefore evident, that when the lever V W is raiſed, it will pull the rudder to the ſide of the veſſel marked A; the ſhip conſequently will be gradually proceeding in a curvilineal line, as long as the lever ſhall be kept up, which will be only until the wheel S moves another tooth; the plug, at that inſtant, paſſes the end of the lever, and the rudder falls into its firſt ſituation; for, on each ſide of the bottom of the veſſel, cloſe to the rudder, there is a large ſpring *m*, which keeps the rudder in a ſtraight poſition, unleſs moved by the lever, or ſome great power. Having explained the machinery for the rowing and ſteering of the ſhip, I ſhall proceed to the explanation of the laſt movement, *viz.* by what means ſhe is to fire her combuſtibles, at the moment ſhe is ſuppoſed to arrive at the place of deſtination, that is, in the enemy's harbour. *p*, is a gun-lock; *q*, the trigger;

trigger; and *r*, a wire leg, connected with the pull of the trigger. *s*, is a ſmall iron lever, which goes behind the wheel S, and moves upon a joint at *t*, which is connected with the leg of the trigger at *r*. On the farther ſide of the wheel S, there is a ſcrew hole in each tooth, and the teeth are numbered the ſame as on this ſide; and an iron plug is ſcrewed on the tooth, on the farther ſide of the wheel S, whoſe number anſwers to the number of ſtrokes the engine is to make for the ſhip to arrive at the place appointed; conſequently, when the numbered cog, in which the plug is fixed, comes to the end of the lever at *z*, it immediately forces it down, which pulls the trigger *q*, and ſets fire to the combuſtibles with which the ſhip is filled.

Fig. 2. is meant to repreſent an enemy's port. A, the harbour. *b b b*, &c. the ſhipping in the harbour. B C D E, the rocks or ſhore. *e e e*, &c. the Engliſh fleet. The arrow F the fire ſhip. Then, for example, ſuppoſe the diſtance from the Engliſh fleet to the enemy's in harbour to be ſuch as to require the engine to make 120 ſtrokes, to row the fire ſhip ſo far. It will appear, that the machinery ſhould be arranged exactly as it is in Fig. 1; for the fire ſhip muſt go on ſtraight, until ſhe arrives at the end of the rock at C, when ſhe muſt begin to

turn the rudder, to proceed in a curvilineal line round the point of the rock to G, which will make up to that place 80 strokes; the plug in N° 60 will then pass the end of the lever, and the rudder consequently fall again into its first straight position, and the vessel will be rowed on, in a straight line, into the harbour from 80 to 120; when the plug in the wheel S, (which plug is screwed into the farther side of that wheel, in tooth N° 120,) will fall upon the lever near z, will consequently pull the trigger, and fire the combustibles.

Fig. 2.

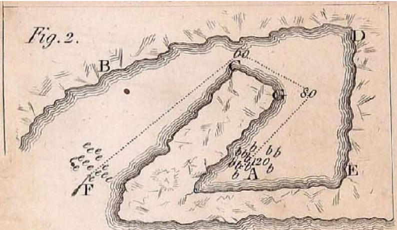
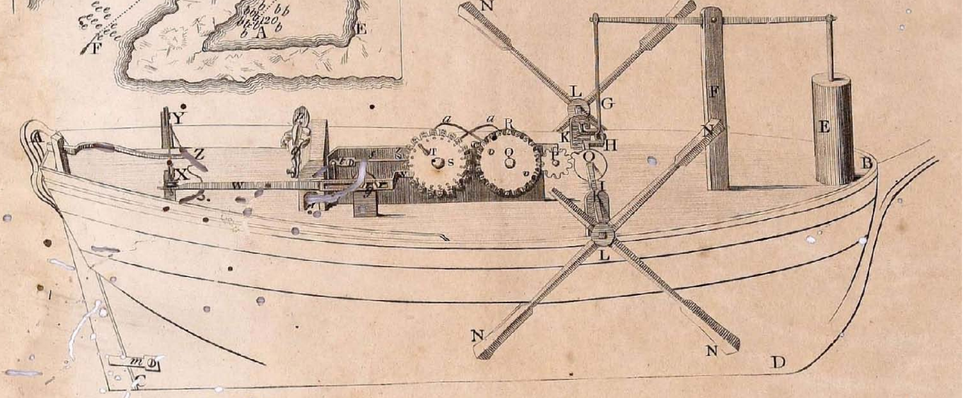


Fig. 1.



LV. *Conclusion of M.* Samuel Bernard's *Description of the Manner of polishing and silvering Plates for Looking-Glasses, at the Manufactory in the* Fauxbourg St. Antoine, *at Paris.*

(From Page 358.)

Fourth Operation. After the third operation, the plates are again examined. By holding them up to the light, it is seen whether they have any defects, such as flaws, air bubbles, or cavities. If they have any cavity which may be taken away by fresh grinding, they are again laid upon the table, and ground: but, if the cavity is so deep that it cannot be taken away in that manner, without consuming a great deal of time, and rendering the plate very thin, the plate is cut into various pieces, in the same manner as is done when it has originally any defect of consequence. These pieces, which are always left as large as possible, serve to make looking-glasses of a smaller size: but, in that case, the whole of them sell for much less than they would have sold for if they could have been kept, without defects, in

one

one piece. When the plates have been examined, as before mentioned, they are made perfectly ſquare; the ſharpneſs of their edges is alſo taken off, by rubbing a piece of glaſs againſt them, ſo as to give them a kind of bevel.

They are then ground afreſh, in the manner before deſcribed, by rubbing them with plates of glaſs, fixed in frames furniſhed with handles; but, inſtead of ſand, emery (a ſort of red oxide of iron) is made uſe of: it muſt be finer and finer, as the work advances, and no leſs than four kinds of it (of different fineneſs) are uſed. When the plates are perfectly ſmooth, they are to be rendered brilliant, the manner of doing which, I ſhall now deſcribe.

Fifth Operation. The plate is laid upon a woollen cloth; but it is firſt coloured red on the under ſurface, that the degree of tranſparency and brilliancy may be perceived. It is then covered with a powder, which the workmen call *Rouge d'Angleterre*, compoſed of the reſiduum from the diſtillation of aqua fortis *, mixed with vitriol of iron

* The diſtillers of aqua fortis make uſe of a clay which contains a great deal of pyrites or vitriol of iron: with this they mix nitre, and proceed to diſtillation. A part of the nitric acid is decompoſed, which gives its oxygen to the ſulphur of the pyrites, and thereby cauſes it to paſs into the ſtate of ſulphuric acid. This acid combines with the potaſh, (another

iron and common ſalt. In this mixture, a decompoſition takes place: the ſulphuric acid of the vitriol of iron combines with the ſoda of the common ſalt, and the oxide of iron is ſeparated. By waſhing the mixture, the muriatic acid of the ſalt (which has perhaps diſſolved a certain portion of the oxide of iron) is taken away, and alſo the ſulphate of ſoda which is formed. The eſſential part of the above mixture ſeems to be the oxide of iron: in fact, emery, which is commonly uſed for poliſhing, is an oxide of iron. The reſiduum of aqua fortis contains oxide of iron, an additional quantity of which is produced from the mixture of vitriol of iron and common ſalt. But theſe oxides are in a ſtate of greater diviſion than emery; and the clay, being of a ſoft nature, alſo helps to render them leſs rough; they therefore wear the glaſs leſs, and, of courſe, poliſh it to a higher degree, than emery. When the plate is covered with the powder abovementioned, the workman has a ſort of bruſh, the bottom of which conſiſts of a kind of felt or velvet, and the top projects on each ſide, ſo that

(another conſtituent principle of the nitre,) and the nitric acid, expanded by the heat, riſes in diſtillation. The reſiduum then conſiſts of (firſt) ſulphate of potaſh, (ſecondly) oxide of iron, produced by the decompoſition of the pyrites, and (thirdly) clay. By waſhing this reſiduum, the ſulphate of potaſh is taken away.

the workman can lay hold of it with both his hands. Having covered the brush with the powder, he rubs the glass with it: but, as it is necessary that a continual pressure should be applied, which would be very fatiguing, a kind of spring is made use of, three or four feet long, made of a piece of flexible wood, rendered still more elastic, and less liable to break, by means of cord, or of parchment. At one end of the wooden spring is an iron point, rather blunt, which presses above against a board suspended over the head of the workman, and enters into the board a sufficient depth to prevent its slipping, but not so much as to occasion any difficulty in changing its place. The other end of the spring, (which is covered with skin, that it may be laid upon the glass without danger, when the brush is taken off,) fits into the handle of the brush, but is not fixed to it, as it is necessary that the brush should be easily taken off, when a fresh quantity of the composition is to be applied upon it. By means of the above contrivance, the workman has nothing to do but to push the brush backwards and forwards, without being obliged to press upon it. It must, however, be evident, that there is a point upon which the spring (being there most bent) presses with most force, in consequence of which, the plate would, at that part, be worn hollow. To avoid

avoid this, the workman places the ſpring in ſuch a poſition that its greateſt preſſure is upon the middle of the plate: he then begins to make uſe of his bruſh, paſſing it moſt frequently over thoſe parts on which the ſpring preſſes with leaſt force; by which means, every part is equally poliſhed. In order that the bruſh may leave no traces of its courſe upon the plate, the workman takes care to move it in all directions. When the glaſs is thought to be ſufficiently poliſhed, it is placed upon a carpet of a dark green colour, which ſhews whether all the parts have the ſame degree of brilliancy. Thoſe parts which have not been ſufficiently poliſhed appear whiter; they are marked, and the workman goes over them again.

It has been propoſed to make uſe of machines for poliſhing plates of glaſs. This would indeed ſave a great deal of hand-labour, but a machine acts uniformly, and, as it were, blindly; whereas, a workman ſees thoſe parts of the plate which ſtand moſt in need of his labour and attention. Sometimes, in conſequence of the roughneſs of the plate in certain parts, ſuch a degree of friction is produced as makes it neceſſary to proceed more gently with the work. A machine acts always with the ſame degree of force, from which there would ariſe great danger of the plates being broken. It would therefore be hardly poſſible to make uſe of machines for the firſt or ſecond

cond operation; but I think they might be advantageouſly employed for the third and fourth. Such machines have already been deſcribed and executed.

Manner of ſilvering the Plates.

This operation is performed upon a large table, of ſtone, or of very thick wood, perfectly ſmooth and flat, and covered with grey paper, thoroughly ſtretched: the table is moveable on an axis, in order that it may be inclined, ſo as to cauſe the mercury to run into a groove made round the table. On this table is ſpread a ſheet of tin-foil, well cleaned, and which has been hammered after being laminated. The workmen think it is neceſſary the tin-foil ſhould be hammered, probably becauſe, by being hammered in all directions, its texture is made more equal than it is left by the rollers, which, by ſtretching it more one way than the other, are apt to render it fibrous. A ſmall quantity of mercury is poured upon the ſheet, and ſpread all over its ſurface, ſo as juſt to moiſten it. A larger quantity is then poured on, enough to cover the ſheet to a certain thickneſs; which thickneſs is always the ſame, and amounts to ſome lines. This requires ſome explanation.

There

There are certain ſubſtances to which mercury has more affinity than to others. When this affinity is much leſs than that of its particles to each other, it adheres a little to theſe ſubſtances, but does not ſpread over them, or ſink into them. Of theſe ſubſtances it is ſaid, that they are not *moiſtened* by the mercury. (What is here ſaid of mercury may be applied to any other liquid ſubſtance.) If a ſmall quantity of mercury is poured upon a ſubſtance of this nature, which has a ſurface perfectly flat and horizontal, it evidently preſerves a ſpherical form, provided the globule is ſo ſmall that its weight is not ſufficient to overcome the force which keeps all its particles arranged in the form of a ſphere, round a common centre. If more mercury is added, until a depreſſion is perceived upon the ſurface of the globule, and the height or vertical diameter of this flattened ſphere is meaſured, it will be found that, whatever quantity of mercury is afterwards added, the height or diameter of the globule cannot be increaſed; but the mercury will ſpread itſelf horizontally, and always in a circular form, until the circumference of the circle extends to the edge of the ſurface upon which it lies: it will then run off, ſuppoſing it to have no affinity, or very little, with the ſubſtance upon which it is poured; that is, if it is poured upon the middle of a ſquare ſurface, it will not extend

extend itſelf into the angles thereof, but will run off as ſoon as it has reached the ſides. But if, on the contrary, a ſmall quantity of mercury is poured upon a ſubſtance with which it has ſufficient affinity to become moiſtened by it, the following circumſtances take place. Firſt, it will be ſeen that the globule is leſs thick, becauſe its affinity with the ſubſtance (being equal to a force preſſing on it) produces a depreſſion at the top of the globule. Secondly, it will cover the whole ſurface of the ſubſtance; becauſe, ſuppoſing, as before, the ſurface of the ſubſtance to be ſquare, it will not (when it has arrived at the edges of the ſquare) tend to ſpread any farther, except by its weight; whereas, towards the corners, it will tend to ſpread farther, both by its weight and by its affinity with the ſubſtance. Thirdly, when it has covered the whole ſurface, it will not immediately run over, becauſe it will ſtill be a little retained by its attraction for the ſubſtance, ſo that a ſmall quantity of mercury may yet be added, without cauſing it to run over; a circumſtance which gives a little latitude to the workman. Hitherto, the mercury remains of the ſame height upon the tin-foil, which height can only be increaſed, in a ſmall degree, towards the end, and varies according to the degree of its affinity with the ſubſtance on which it is poured. It is evident that it muſt depend, firſt, upon the adherence

herence of the particles of the fluid with each other. Secondly, on the ſpecific gravity of this fluid. Thirdly, on its adherence to the ſubſtance on which it is put. The height above mentioned may be taken by obſervation: the ſpecific gravity of the fluid is alſo known; and tables have been given, by different philoſophers, of the adherence of mercury, and that of other fluids, to various ſubſtances. If their formulæ are exact, it is clear that nothing remains unknown, except the adherence of the particles of the fluid to each other, which may be found by means of the data above mentioned. Or, if the adherence of the particles of the fluid to each other were known, that of the fluid to different ſubſtances would be obtained.

When the ſheet of tin-foil is covered with mercury, the application of the plate of glaſs to it muſt not be too long delayed, becauſe, in that caſe, the mercury would diſſolve the tin-foil. As the ſurface of the mercury always becomes a little calcined, or may have acquired a little duſt, or other foreign ſubſtance, a ſmall quantity of water is poured upon it; and, when the plate is about to be laid on, a bruſh, and afterwards a hare's foot, is paſſed over it, which entirely removes the calcined pellicle, &c. A band of parchment, extending ſome lines above the ſurface of the mercury, is put upon the edge of the

the table; and the plate, being firſt made very clean and dry, is ſlipped over the parchment. It is neceſſary that the plate ſhould ſink a little into the mercury, that the air may not get between it and the metal; but great care muſt be taken that it does not ſink too deep, becauſe, if it ſhould touch the ſheet of tin-foil, it would tear it. The management of this part of the proceſs is more eaſy than might be ſuppoſed; for the glaſs plate, being of leſs ſpecific gravity than the mercury, would float upon it, conſequently, to make the plate ſink a little into the mercury, nothing more is neceſſary than to preſs upon it. When the plate is properly placed upon the tin-foil, (which ought to extend on every ſide a few lines beyond the plate,) the table muſt be gently inclined: a great part of the mercury then runs off, and the plate comes in contact with that part which adheres to the tin-foil. A ſhort time after, the plate is covered with a woollen cloth, and ſeveral weights are laid on it, to increaſe its adherence to the tin-foil. When it has been in this ſituation a ſufficient time, the projecting edges of the tin-foil are cut off, and the plate is taken up.

Mercury has ſome adherence to glaſs; and, if it does not moiſten it, it is becauſe the adherence of its particles to each other is greater than that of thoſe particles to glaſs. But, in the preſent caſe, the mercury, being fixed by the tin, no longer

ger tends to run into globules, but adheres to the glafs, particularly when there is no air between them. By its means, the tin-foil adheres ftrongly to the glafs; in the fame manner as, by the help of water, the laminæ of cryftals (thofe of fulphate of lime, for inftance,) adhere to each other. The mercury alone here acts as a mirror. If it is taken from the glafs, it generally appears to be covered with a white pellicle; and, when looked into reflects objects more perfectly than the beft looking-glafs. The glafs, therefore, only ferves to prevent the mercury from being calcined, and caufes its furface to be always perfectly even. As it is neceffary that the rays of light fhould pafs through the glafs, to be reflected by the mercury, and that they fhould pafs it a fecond time, to come to the eye, it muft be evident that the glafs ought to be perfectly even, tranfparent, and colourlefs. The tin ferves only to lay hold of the mercury, and to fix it againft the glafs; for, by laying a plate of glafs upon mercury, or by inclofing a fmall quantity of that fluid between two plates, a looking-glafs might be made, which would act exactly like the others, but would be more heavy, and lefs convenient for moving from place to place.

LVI. *On the Means of ſeparating (in the moiſt Way) the Zinc combined with Copper, in the Mixtures called Braſs, Pinchbeck, &c. with the Analyſis of ſome Greek and Roman Coins. By M.* Dizé.

FROM THE *JOURNAL DE PHYSIQUE.*

THE ſeparation of zinc, when it is united to various metallic ſubſtances, and particularly when it is united to copper, with which it has great affinity, is very intereſting both to chemiſtry and to the arts.

The ſolubility of zinc in almoſt all the acids, the facility with which it is calcined, and at the ſame time rendered volatile, by a certain degree of heat, are circumſtances which preſent many difficulties, when we ſeek to deſtroy its union with a metal which has nearly the ſame affinities as itſelf.

It is very difficult to ſeparate zinc from copper by means of ſolution and ſimple cryſtallization, as it always happens (whatever precautions are taken) that the two ſalts reſulting from the ſolution of a mixture of theſe two metals, although differing

in

in form and colour, contain, within the texture of their cryſtals, more or leſs of the baſis of each other, or of their ſalifiable principle ; and this mutual participation of theſe two ſalts increaſes, in proportion as the ſolution approaches to cryſtallization. The method, now in uſe, of ſeparating zinc from any metal with which it is united, by means of ſublimation in a great degree of heat, is more adapted merely to ſhew the preſence of zinc, when mixed with any metal, than to determine its quantity with preciſion.

Macquer and Baumé mention the method juſt deſcribed ; but the want of accuracy, in that analyſis, renders it very inferior to thoſe proceſſes by means of which we have arrived at our preſent degree of perfection.

In fact, if, in the manner pointed out by theſe two chemiſts, we expoſe a known quantity of copper mixed with zinc to a ſtrong fire, in order to determine how much zinc it contains, the zinc will riſe, and be conſumed upon the ſurface of the mixture : its combuſtion and its oxidation will indeed ſhew its preſence, but its proportion can only be aſcertained by obſerving what loſs of weight the mixture has ſuſtained.

But the above is not the only difficulty, for it will be afterwards neceſſary to diſcover, by ſome certain criterion, whether the whole quantity of zinc which the mixture contained was con-

 ſumed,

ſumed, and whether the degree of heat made uſe of was ſufficiently ſtrong to force every minute portion of zinc to overcome the attraction which united it to the metal with which they were mixed. How alſo will it be poſſible to appreciate the weight of the other metallic ſubſtances which may have been in the mixture, and which were oxidated or volatilized with the zinc?

Beſides, the copper itſelf is more or leſs oxidated during the combuſtion of the zinc and thus acquires a greater weight. This neceſſarily produces an error in the calculation, when we endeavour to determine the weight of the metal which has been volatilized or burnt, by the weight of that which remains fixed.

I have proved the imperfection of the means here ſpoken of, by various experiments: and, in ſpite of all my endeavours to render thoſe means fit to be employed, I could never prevent the oxidation of the metal remaining after the combuſtion of the zinc it contained, except by heating the mixture ſurrounded by, and preſſed into, powdered charcoal. And, even with this precaution, I have found evident variations in the weight of different parts of the ſame mixture of copper and zinc, when expoſed in the ſame furnace, and heated for the ſame ſpace of time.

Having, therefore, convinced myſelf that fire was a re-agent of too inconſtant a nature to give

equal

equal products, from which invariable reſults might be obtained, I ſubmitted ſeveral different kinds of braſs to analyſis in the moiſt way; by which method of operating, I obtained reſults more conſtant and exact.

Experiment I. I took one hundred parts of braſs, ſuch as is ſold in the ſhops, and diſſolved them in a ſufficient quantity of pure nitric acid.

When the copper with which the braſs was made contains tin, or when any of that metal has been added to the braſs, in order to harden it, the tin is precipitated, during the diſſolution, in form of an oxide, and ſometimes it is found mixed with a certain portion of red oxide of iron. In this caſe, the ſolution of nitrate of braſs muſt be decanted, in order to ſeparate the oxides of tin or iron.

Experiment II. None of the various acids, upon being mixed with the ſolution of nitrate of braſs, took the copper, or the tin, from the nitric acid.

Experiment III. One hundred parts of common braſs were diſſolved in pure nitric acid. This ſolution was decompoſed by means of potaſh, and the precipitate which was formed (after being well waſhed) was diſſolved in a ſufficient quantity of diluted ſulphuric acid. By this means, I obtained a ſolution of ſulphate of braſs, to which I added ſix times as much diſtilled water.

I then endeavoured to ſeparate the copper from its menſtruum, by means of ſome metal which, by having leſs affinity with the ſulphuric acid than zinc, ſhould precipitate the copper alone.

Iron appeared to me to have this quality. In conſequence of which, I plunged a flat piece of iron, made perfectly clean, into the ſolution of braſs above ſpoken of, diluted with ſix times the quantity of diſtilled water. The copper was immediately diſplaced by the iron, and precipitated in a metallic form. The liquor then contained ſulphate of iron, mixed with ſulphate of zinc.

Having convinced myſelf that an infuſion of galls has no action upon ſulphate of zinc, I poured into the ſolution of ſulphate of iron and of zinc, a ſufficient quantity of an aqueous ſolution of galls to precipitate all the iron. The ſolution was again diluted with a proper quantity of pure water, to facilitate the precipitation of the gallate of iron. When it was all precipitated to the bottom of the veſſel, the liquor was filtered, and the gallate of iron, which remained upon the filter, was carefully and repeatedly waſhed.

The liquor could then contain nothing but ſulphate of zinc, mixed with a ſmall portion of infuſion of galls, which remained after the precipitation of the iron.

In order to obtain the ſulphate of zinc in a pure ſtate, I evaporated to dryneſs the whole of the

the remaining solution, in a glass vessel. I put the matter into a crucible, which I heated to such a degree as only to char the small portion of tanning principle and of gallate of iron which had been dissolved. After this operation, I digested the charred matter in cold distilled water, and washed it upon a filter, until it appeared to be deprived of all the sulphate of zinc it had contained.

The liquor was clear and limpid. Prussiate of lime did not discover any iron in it; but a solution of pure carbonate of soda precipitated the zinc it contained, of a blue colour. I ascertained that this precipitate was nothing but carbonate of zinc, by restoring it, mixed with powdered charcoal, in an earthen retort, the neck of which was plunged into water.

I do not offer the process I have just described as the most ready, or the most easy manner of separating, in the moist way, zinc which happens to be mixed with copper. The slowness with which the gallate of iron is precipitated, and the quantity of liquor necessary to be evaporated, in order to determine the weight of a very small quantity of zinc, render the operation tedious, and occasion some difficulties, which may make its success doubtful in the hands of those who are not accustomed to this kind of analysis. I thought, nevertheless, that it was right to describe this ex-

 periment,

periment, to ſhew the obſtacles we are obliged to overcome, when we ſeek to deſtroy the union of two ſubſtances which are governed by the ſame laws of affinity.

Experiment IV. Of the various ſubſtances which have the property of taking copper from the nitric acid, lead appeared to me the moſt eligible. Firſt, becauſe it forms with that acid a very ſoluble nitrate of lead. Secondly, becauſe the lead may be afterwards ſeparated from the acid by means of ſulphuric acid, which ſeparates it in the form of ſulphate of lead, an almoſt inſoluble ſubſtance. Thirdly, becauſe zinc has a greater affinity with nitric acid than lead.

For theſe reaſons, I diſſolved one hundred parts of braſs in very pure nitric acid; and, having diluted the ſolution with ſix times its quantity of diſtilled water, plunged into it a flat piece of lead, very pure, and well cleaned. The nitrate of copper was immediately decompoſed by the lead, and the copper was precipitated in a metallic ſtate, while the lead united itſelf to the nitric acid.

In proportion as the copper is ſeparated from its menſtruum by the lead, the ſolution loſes its blue colour; and, when the copper is entirely precipitated, it acquires a hue of a light lemon colour. It muſt not, however, be concluded, from ſo uncertain a criterion, that the liquor contains

thus no more copper: the moſt exact proof that can in this caſe be obtained is, that the piece of lead (being well cleaned afreſh) preſerves its metallic ſtate, after having remained for ſome hours in the ſolution, heated to ebullition.

It often happens, towards the end of the precipitation of the copper by means of lead, that the ſurface of the lead becomes oxidated in the firſt degree, being covered with a dark grey oxide of lead, which mixes with the copper that is precipitated in a metallic form. To ſeparate the metallic copper completely from this oxide of lead, the whole of the precipitated metallic ſubſtance muſt be re-diſſolved in freſh nitric acid, and the lead muſt be precipitated with ſulphuric acid. Afterwards, the nitrate of copper muſt be decompoſed by pure ſoda, and the weight muſt be aſcertained, either by reſtoring the carbonate of copper, or by ſubtracting the carbonic acid which has combined with it.

Thus, although I was perfectly convinced, by the means I have juſt deſcribed, that all the copper was ſeparated, I proceeded to decompoſe the nitrate of lead by means of ſulphuric acid; which took the lead from the nitric acid, and precipitated it in the form of ſulphate of lead. I ſeparated this inſoluble ſalt by filtration; and, after having well waſhed it in pure water, I evaporated the whole of the liquor to dryneſs, in an earthen veſſel.

veſſel. The reſiduum obtained by this evaporation, was diſſolved in pure cold water, and the ſolution was afterwards filtered, to ſeparate from it any ſmall portion of ſulphate of lead which it might contain.

By the above proceſs, the zinc which entered into the compoſition of one hundred parts of braſs remained alone diſſolved in the nitric acid; from which I afterwards precipitated it in the form of carbonate of zinc, by means of pure carbonate of ſoda.

The carbonate of zinc I obtained from one hundred parts of braſs, after being well waſhed and dried, weighed twenty-five parts.

Experiment V. In order to calculate the quantity of metallic zinc that might be contained in a given weight of carbonate of zinc, I diſſolved one hundred parts of pure zinc in a ſufficient quantity of nitric acid, and precipitated it with carbonate of ſoda. When the product was well waſhed and dried, it was found that the hundred parts of zinc had acquired eighty parts.

From this experiment, I am enabled to eſtimate, accurately, the quantity of zinc contained in the hundred parts of braſs of Experiment IV, as follows:

Braſs of the ſhops, . . .		100 parts.
Copper	87 parts	100 parts.
Metallic zinc, .	13	

I muſt

I must here remark, that the various specimens of common brass that I have analysed, have generally varied with respect to the proportions of copper and zinc which entered into their composition; and that tin is very often found mixed therein, in the proportion of one or two hundredth parts. These variations will not be thought surprising, when it is considered that most of our brass is brought from other countries, and that its quality must necessarily vary, according to the proportion of zinc made use of, and the manner of making it, in the different manufactories where it is prepared.

A particular kind of brass is prepared at Geneva, on purpose for making the wheels of escapements for watches: parts very essential to the accuracy of the movement. This brass is very beautiful in colour, and possesses great ductility. It is so much prized by watch-makers, that when they meet with ingots of it perfectly ductile, they give a high price for it.

I analysed some of this brass, which Breguet, a watch-maker of great reputation, had given me, and which he assured me was of an excellent quality.

The following are the proportions of this metal.

One hundred parts of brass, prepared at Geneva, for making escapement-wheels, produced

Pure copper,	.	75 parts	} 100 parts.
Metallic zinc,	.	25 parts	

Such are the various reſults I have obtained from the examination of different kinds of braſs, by the method of analyſis herein deſcribed; by which method, it is eaſy to aſcertain the proportions of zinc, in the various kinds of braſs with which we are furniſhed by the ſhops.

Braſs is a metal very much uſed in this country, for making large trinkets, alſo for clock-work, &c.; and, were it only on this account, the variety which I have found in the proportions of its compoſition, muſt be conſidered as an object of conſequence, both with reſpect to its quality and its beauty.

But, when it is conſidered that this metal is alſo uſed for making culinary utenſils, and other veſſels, intended to contain or to prepare various liquors (for the purpoſe of food, &c.) which act upon copper, its compoſition becomes an object worthy the attention of government.

It is therefore to be wiſhed, (for the ſafety of the public, and in order to avoid thoſe dreadful accidents which ſo frequently happen in families, by their confidence in uſing veſſels of braſs, of which even the proportions are unknown,) that the proportion of zinc uſed in the compoſition of the

brafs intended for making fuch veffels, were determined by law. That proportion ought to be fuch, that the particles of this femi-metal might divide and cover thofe of the copper, in fuch a manner that, without injuring its malleability, they might defend it againft the action of acid liquors, or fat fubftances.

This proportion, which it would not be difficult to determine, might be proved, by analyfing, in the moift way here defcribed, all kinds of brafs intended for the making of veffels in which any kind of victuals, &c. is to be prepared or contained.

The alloying of copper with zinc was practifed in the very earlieft ages. The ancients made ufe of this metal for ornamental work, and for making utenfils deftined for the preparation of their food. Indeed, it is impoffible to reflect upon the great ufe the ancients made of a metal fo beautiful and fo ductile, and upon the daily ufe we make of it in our kitchens, without being aftonifhed that it has not yet been determined with precifion what proportion of zinc ought to be employed, in order to deftroy, or at leaft to diminifh as much as poffible, the deleterious quality of the copper, which forms the bafis of this mixture.

The various proportions of zinc I found in the different kinds of brafs which I analyfed in the

moift way, and the dangerous accidents [illegible] daily happen by the [illegible] of brafs veffels, have fufficiently convinced me, that it is of the utmoft confequence that government fhould immediately determine what is the beft proportion of zinc, to be ufed in the fabrication of brafs intended for making kitchen utenfils, &c. all which brafs, to prevent fraud, fhould be properly ftamped.

These experiments are followed by a differtation (which appeared to us not fufficiently interefting to tranflate) intended to prove, chiefly from the authority of Pliny, that though the ancients did not perhaps know how to extract zinc from its ores, yet that they certainly made ufe of the ores of that femi-metal, for making various kinds of brafs, combining it with copper by cementation.

But, to remove (as the author fays) all doubts upon the fubject, he has given the analyfis of five ancient coins; four of which ([illegible] that analyfis) were found to contain zinc.

He

...ad already (see our fourth volume, page ...02,) given an ...ount of the analysis of several Greek and Rom... coins, in which he found only copper and tin; but he observes, that he was not at that time acquainted with the method herein described, of ascertaining the presence of zinc in ... mixture of copper and tin; and therefore attempted only to shew that the art of tempering copper, which the ancients were supposed to possess, was intirely chimerical; and that their copper owed its hardness merely to a quantity of tin mixed with it, in different proportions, according to the use for which the metal was intended.

The following table shews the quantities of tin, zinc, and copper, obtained by analysis, in the moist way, from five different Greek and Roman coins.

Five

Five Coins of different Denominations, *viz.*	Quality of the Metal.	Weight.	Oxide of Tin by Nitric Acid.	Metallic Tin.	Carbonate of Zinc.	Metallic Zinc.	Metallic Copper.	Weight of the Whole.
		Parts.						
Greek Coin,	Harsh, and of a whitish colour.	100	8	4	5	2,78	93,22	100
Sicilian, Do.	Of a very pale copper.	100	11	5,5	10,12	5,5	89	100
Sicilian, Do.	Harsh, with a whitish fracture.	100	5	2,5	0	0	97,5	100
Roman, Do.	Harsh, and as white as bell-metal.	100	1	0,5	6	3,33	96,17	100
Roman, Do.	Colour of brass.	100	0,5	0,25	9	5[illegible]	94,75	100

LVII. *Liſt of Patents for Inventions, &c.*

(Continued from Page 360.)

DAVID HARDIE, of the pariſh of St. James, Weſtminſter, Gentleman; for an improvement in and upon cranes for raiſing and lowering goods into and out of warehouſes, which will conſiderably leſſen the labour uſually required to work them. Dated March 8, 1799.

MICHAEL LOGAN, of Paradiſe-ſtreet, in the pariſh of St. Mary, Rotherhithe, Engineer; for a centrifugal barrel-engine or, central force, for raiſing water, &c. from great depths, applicable to all manufactories or ſyſtems of machinery requiring the action of circular motion, ſuch as, an effectual power in mill-work, water-works, and clock-work. Dated March 8, 1799.

ROBERT DELAP, of Banville, near Bambridge, in the kingdom of Ireland, Bleacher; for œconomical boilers, for ſundry uſeful purpoſes. Dated April 6, 1799.

WILLIAM BRODUM, of the pariſh of Chriſt Church, in the county of Surry, Doctor of Phyſic; for a medicine denominated *Botanical Syrup*, for the cure of ſcorbutic and various other complaints;

plaints; alſo for a me licine denominated *Cordial*, for the cure of conſumptive and many other complaints. Dated April 10, 1799.

SAMUEL REHE, of the pariſh of St. Bride, London, Mechaniſt; for an engine or apparatus for giving motion to water, or other fluids, either for the purpoſe of conveying ſuch fluids from place to place, in any direction, or for mechanical purpoſes; which apparatus is alſo capable of being made the inſtrument for tranſmitting the force of water, or any other of the fluids hitherto uſed as firſt movers in mills and other machines. Dated April 11, 1799.

GEORGE DAVIS, of Windſor, in the county of Berks, Lockſmith; for a double chambered lock, with cylinders, to which pins are affixed, in different directions, inſtead of wards. Dated April 11, 1799.

MARK ISAMBARD BRUNEL, of the pariſh of St. Mary, Newington, in the county of Surry, Gentleman; for a writing and drawing machine, by which two or more writings or drawings, reſembling each other, may be made by the ſame perſon, at the ſame time. Dated April 11, 1799.

END OF VOL. X.

ERRATUM.

Page 287, *for* Edmund Thomaſon *read* Edward Thomaſon.